Early Action Plan
for the
Fayetteville Metropolitan Statistical Area
North Carolina

Planning Today
for Clean Air
Tomorrow

A joint effort by USEPA Region 4, North Carolina Department of Environment and Natural Resources, and the Cumberland County Board of Commissioners, Town of Falcon, City of Fayetteville, Fort Bragg Military Reservation, Town of Godwin, Town of Hope Mills, Town of Linden, Pope Air Force Base, Town of Spring Lake, Town of Stedman and Town of Wade and the Fayetteville Area Metropolitan Planning Organization

March 31, 2004

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1. Introduction

1.1 Background

The Clean Air Act (CAA), as amended in 1990 is the most recent version of a law first passed in 1970. The 1990 Amendment made some major changes in the act, by empowering the US Environmental Protection Agency (EPA) to set up permitting and enforcing programs for larger sources that release pollutants into the air.

In addition, the EPA's principal responsibilities under the Clean Air Act were:

- to set National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to the public health and the environment (**Primary Standards** limits to protect public health, including the health of "sensitive" population such as asthmatics, children and the elderly; **Secondary Standards** limits to protect public welfare, including protection against decreased visibility, damage to animals and crops, vegetation and buildings)
- to ensure that air quality standards are met or attained
- to ensure that the sources of toxic air pollutants are controlled
- to monitor the effects of the program

On July 17, 1997, the EPA promulgated revised National Ambient and Air Quality Standards, addressing changes in the Ozone and Particulate Matter. Soon after, the American Trucking Association sued the EPA in the U.S. Court of Appeals for the DC Circuit disputing the legality of how the standard was set and how it would be implemented. In May of 1999 the Appeals Court ruled against the EPA finding that the Agency had acted in an unconstitutional manner in setting the standards and that the implementation approach improperly ignored CAA requirements dealing with ozone non-attainment areas. The EPA appealed to the Supreme Court. In a decision dated March 26, 2001, the Supreme Court found that the EPA's setting of the standards was constitutional, and that the Agency could set NAAQS at levels necessary to protect public health and welfare without considering costs, however the EPA could not ignore Subpart 2 of the CAA when implementing the 8 hour ozone standard. The final designation of non-attainment for the 8-hour ozone standard will take place on April 15, 2004.

On June 19, 2002, EPA Region 6 endorsed Texas' Protocol for an "Early Action Compact" (EAC). The protocol described attainment of the 8-hour NAAQS for ozone and it provided for Early Reduction Compacts. The purpose of the Compact would be to:

- Develop early voluntary 8-hour air quality plans between Local, State government and the EPA
- Apply to areas that are in attainment for the 1-hour ozone standard, but approach or monitor exceedances of the 8-hour standard
- Designed to develop and implement control strategies, account for growth, and achieve and maintain the 8-hour ozone standard

- Include all necessary elements of a comprehensive air quality plan, but tailored to local needs and driven by local decisions
- Offers more expeditious timeline to achieve emission reductions
- Provides for fail-safe provisions for the area to revert to traditional State Implementation Plan (SIP) process if specific milestones are not met

(Source: Air Quality Update – Sheila Holman – MPO Conference, Rocky Mount, September 26, 2002)

After review of the proposed Compact, the EPA decided to extend participation in the EAC to the entire country. Each area that met the criteria was to have an Early Action Compact Memorandum of Agreement signed by December 31, 2002.

Since the introduction of the revised 8-hour ozone standard, Cumberland County has registered values that will make this area non-attainment for ozone. There are two monitoring sites in Cumberland County: one in Wade and one in Golfview (Hope Mills). To establish if an area will be designated as non-attainment for ozone, the North Carolina Department of the Environment and Natural Resources (NC DENR) Division of Air Quality (DAQ) averages the fourth highest reading during an ozone season (May through September) for three consecutive years. If the average is of 0.085 ppm or above, the area will be designated as non-attainment. Cumberland County has registered a reading of 0.087 for the years 2001-2003 for both monitoring sites, which is a "marginal" reading, making participation in the EAC a logical step for this area.

1.2 Stakeholders Involvement

The Cumberland County Board of Commissioners approved the EAC and then Chairman Baggett signed the Memorandum of Agreement on December 13, 2002. During the following months, every municipality within the then Metropolitan Statistical Area signed a resolution of support of and participation in the Early Action Compact. Fort Bragg Military Reservation and the Fayetteville Area MPO also agreed to support this effort. Commissioners instructed the Planning and Inspections Director to oversee the EAC process and the Fayetteville Area Metropolitan Planning Organization (FAMPO) Staff to provide administrative and logistical support. FAMPO staff immediately began to solicit volunteers to participate in the process. Efforts were made to contact environmental and health groups to join in this effort. Both the Sierra Club and the American Lung Association could not find individuals interested in participating, because there are no local chapters in this area, and volunteers would have to commute from the Raleigh/Durham area. One of the volunteers is a member of the Sandhills Area Land Trust (SALT) Board of Directors, but agreed to serve as a citizen Stakeholder, and not as a SALT representative. Thus no major environmental group is a member of the Cumberland County Stakeholders. **Table 1** lists the names and affiliations of Stakeholders as of March 2004.

On April 3, 2003, the first Cumberland County Air Quality Stakeholders' Meeting took place in the Pate Room of the Library Headquarters. The purpose of the meeting was to give the newly appointed Stakeholders an opportunity to familiarize themselves with the compact efforts and to communicate with representatives of NC DENR and US EPA.

Table 1 - Air Quality Stakeholders of Cumberland County as of March 2004.

NAME	AFFILIATION
Dr. Adegoke O. Ademiluyi	Fayetteville State University Department of Government and History
Ms. Charlotte G. Agnew, RN	Citizen
Commissioner Eleanor Ayers	Town of Stedman
Commissioner Talmage S. Baggett	Cumberland County
COL. Gregory G. Bean	Fort Bragg Military Reservation
Mr. Steven Blanchard	Public Work Commission
Mr. George Breece	Citizen
Alderwoman Marguerite Corgan	Town of Spring Lake
Mayor Edwin S. Deaver	Fayetteville Area Metropolitan Planning Organization
Mr. Daniel Dodd	Construction Industry - Barnhill Contracting Company
Mr. Robert Duffy	Major Industries
Dr. Joseph Follet	Medical Representative
Mr. Michael Green	Cohen & Green
Mr. Demetrius Haddock	Citizen
Mr. Henry Holt	Petroleum Distributor – Holt Oil Co.
Mr. Jay Jarvis	Chemical Industry -Univar USA Inc
Mr. Karl Legatski	Citizen
Mr. Bill Martin	Cumberland County Business Council
Councilman Robert Massey	City of Fayetteville
Dr. Harold E. Maxwell D.D.S.	Cumberland County Board of Health
Commissioner Eddie Maynor	Town of Hope Mills
Mr. Donovan McLaurin	Home Builders Association
Dr. Larry Norris	Fayetteville Technical Community College
Ms. Shirley Pillow	Airport Commission
Mr. Steven Schultz	Cape Fear Health Systems
Ms. Denise Sykes	Town of Falcon, Godwin, Linden, Wade
Mr. Stephen C. Waters, Sr.	Ashland Industries

On May 15, 2003 the Stakeholders held the first regular meeting. At that time the Committee unanimously agreed to use the "Consensus" method to review and/or approve related documents and processes and selected a Chairman, Mr. George Breece, and a Vice-Chairman, Mayor Edwin S. Deaver. The Stakeholders approved a Logo (see cover of this document) and adopted the goal to provide ***"A healthful environment for all current and future citizens of Cumberland County"***

The Stakeholders met monthly for the first three months and now meet quarterly at a minimum, or as required.

The Stakeholders' Committee is supported by an Air Quality Technical Committee, which meets more often and provides the Stakeholders with technical information and administrative assistance. The Public Involvement does not end with the Stakeholders. An aggressive process of education and outreach into the community has been documented since the beginning of this endeavor, to include involvement of the Public School Systems (Cumberland County and Fort Bragg/Pope AFB), utility providers, and of any Organization requesting presentations. The Air Quality web page, maintained by FAMPO staff, provides information on the local effort and related links (http://www.fampo.org/airquality.htm). The Fayetteville MPO is also a community partner in the "It All Adds Up to Cleaner Air" U.S. Department of Transportation (US DOT)/EPA initiative, and uses and distributes the material available through the IAAU web site.

Minutes of the Stakeholders' and Technical Committee meetings and list of outreach and presentations are on file and open to the public.

1.3 Cumberland County Characteristics

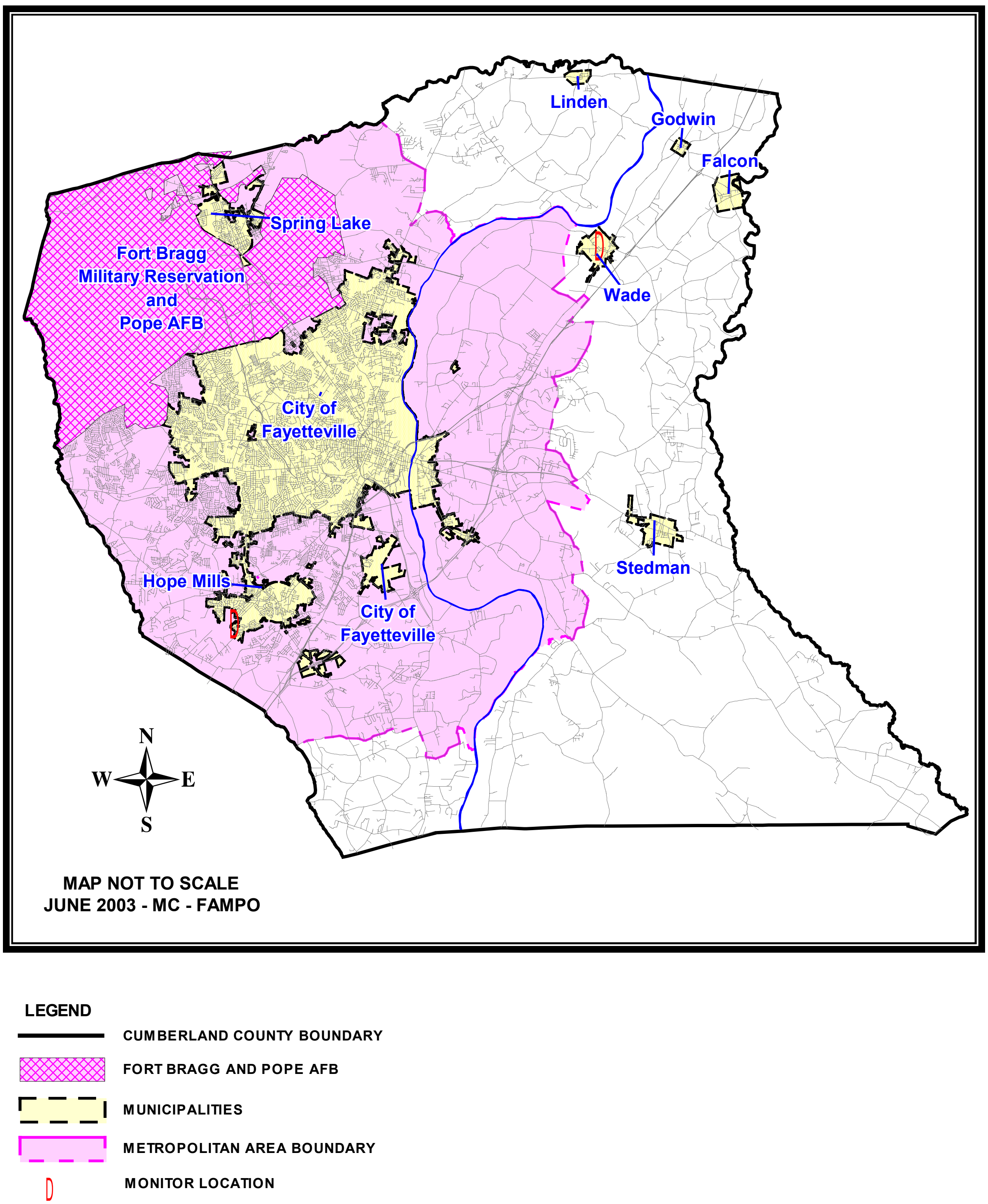
The Cumberland County landscape is a mixture of urban and rural lands. The 2000 census population for Cumberland County was of 302,963, of which 20,540 is rural population and 282,423 is within the Urbanized Area Boundary. Population density is also varied, as shown in **Table 2**. Because of the difference in land use and densities, care was exercised when proposing and selecting strategies to be implemented by such

Table 2. Census 2000 Demographic Information

JURISDICTION	POPULATION	AREA (Sq.Mi.)	DENSITY/Sq.Mi.
Falcon	328	1.26	262.4
Fayetteville	121,015	59.96	2,059.2
Godwin	112	0.25	450.2
Hope Mills	11,237	6.24	1,844.6
Linden	127	0.48	263.8
Spring Lake	8,098	3.69	2,203.9
Stedman	664	1.37	484
Wade	480	1.32	367.6
Cumberland County	**302,963**	**658.46**	**464.2**

Source: U.S. CENSUS BUREAU – Census 2000 diverse jurisdictions. The Cantonment Area of Fort Bragg Military Reservation, one of the largest military installations in this country, and Pope Air Force Base are also located within Cumberland County, as shown on **Figure 1**. The presence of such a large military facility is an additional factor in the population makeup of our area. Cumberland County has a combined minority population of approximately 45%, with 34.9% African-American. Statistical information shows that 12.8% of the overall population is below the poverty level (Source: U.S. Census Bureau – Census 2000). All of these factors were taken into consideration when preparing for the implementation of the Early Action Plan.

Figure 1 – Proposed Non-Attainment Area for the Fayetteville MSA



1.31 Local and Regional Efforts

In April 2001, inspired in part by Governor James Hunt's 1998 challenge on sustainability and smart growth, Fort Bragg Military Reservation embarked on the difficult journey to become a sustainable installation. As part of this effort, several individuals within the surrounding counties began working with the Military Installation to aid in the process, including the planning and implementation schedule of air quality initiatives for the metropolitan area. At that point, a sustainable region was the next logical and necessary step. In partnership with the North Carolina Department of Environment and Natural Resources and stakeholders from the surrounding counties and communities, Sustainable Sandhills began in February 2003, covering the environmental needs and wants of a six county region. Subsequently, a Steering Committee of interested participants was formed. Later, the Steering Committee became the Leadership Council and many of the individuals involved in this endeavor are also members of the Cumberland County Air Quality Stakeholders and/or Technical Committee. The Sustainable Sandhills Action Plan describes five focus areas: Air, Energy, Land Use, Materials Use and Waste, and Water.

The local and regional efforts to attain sustainability began prior to the development of the EPA's Early Action Compact, demonstrating the commitment of this area in attaining and maintaining a healthy environment now, and for generations to come. The Cumberland County Air Quality Stakeholders/Technical Committee, Sustainable Fort Bragg and Sustainable Sandhills participants are working together to ensure a united campaign and to avoid duplicated efforts.

1.4 Modeling Background

The modeling analysis is a complex technical evaluation that begins by selection of the modeling system and selection of the meteorological episodes. North Carolina Division of Air Quality (NCDAQ) decided to use the following modeling system:

- Meteorological Model: MM-5 – This model generates hourly meteorological inputs for the emissions model and the air quality model, such as wind speed, wind direction, and surface temperature.
- Emissions Model: Sparse Matrix Operator Kernel Emissions (SMOKE) - This model takes daily county level emissions and temporally allocates across the day, spatially locates the emissions within the county, and transfers the total emissions into the chemical species needed by the air quality model.
- Air Quality Model: MAQSIP (Multi-Scale Air Quality Simulation Platform) – This model takes the inputs from the emissions model and meteorological model and predicts ozone hour by hour across the modeling domain, both horizontally and vertically.

The modeling system being used for this demonstration and the episodes being modeled were discussed in detail in the June 30, 2003 progress report (see Appendix D).
The following historical episodes were selected to model because they represent typical meteorological conditions in North Carolina when high ozone is observed throughout the State:

- July 10-15, 1995
- June 20-24, 1996
- June 25-30, 1996
- July 10-15, 1997

The meteorological inputs were developed using MM5 are discussed in detail in Appendix D.

The precursors to ozone, Nitrogen Oxides (NOx), Volatile Organic Compounds (VOCs), and Carbon Monoxide (CO) were estimated for each source category. These estimates were then spatially allocated across the county, temporally adjusted to the day of the week and hour of the day and speciated into the chemical species that the air quality model needs to predict ozone. The emission inventories used for the current year and future year modeling are discussed in detail in Section 4.

The State, Federal and Local control measures currently in practice and those being implemented in the future to reduce point and mobile (highway and nonroad) source emissions are discussed in Section 5.

The status of the modeling work is discussed in Section 6.

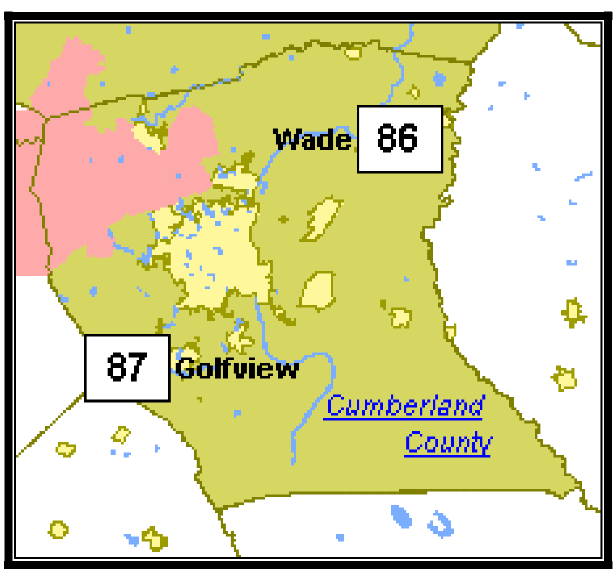
2. Overview of Air Quality In Cumberland County

The U.S. Environmental Protection Agency (EPA), under the authority of the Federal Clean Air Act, regulates outdoor air pollution in the United States. The EPA sets National Ambient Air Quality Standards (NAAQS) for six "criteria pollutants" that are considered harmful to human health and the environment.[1] These six pollutants are carbon monoxide, lead, ozone, nitrogen dioxide, particulate matter and sulfur dioxide. Particulate matter is further classified into two categories: PM 10, or particles with diameters of 10 micrometers or less, and fine particulate matter (PM 2.5), particles with diameters of 2.5 micrometers or less. Levels of a pollutant above the health-based standard pose a risk to human health.

The NCDAQ monitors levels of all six criteria pollutants in Cumberland County and reports these levels to the EPA. According to the most recent data, Cumberland County is meeting national ambient standards for five of the pollutants, but is not meeting the Federal 8-hour standard for ground-level ozone. Federal enforcement of the ozone NAAQS is based on a 3-year monitor "design value". The design value for each monitor is obtained by averaging the annual fourth highest daily maximum 8-hour ozone values over three consecutive years. If a monitor's design value exceeds the NAAQS, that monitor is in violation of the standard. The EPA may designate part or all of the metropolitan statistical area (MSA) as nonattainment even if only one monitor in the MSA violates the NAAQS.

There are two ozone monitors in Cumberland County. One of the monitors is located northeast of Fayetteville (Wade) and the other is southeast of Fayetteville (Golfview), as shown in Figure 2-1.

Figure 2-1: Cumberland County 8-hour Ozone Monitor Design Values 2001 – 2003



For the 3-year periods 2000 – 2002 and 2001 – 2003, both monitors marginally violated the 8-hour ground-level ozone NAAQS, see Table 2.1. The historical ozone monitoring data, including the years for which the design values are based on, is listed in Table 2.2. Monitor design values are dependant on which three-year period the 4th highest 8-Hour ozone concentrations are averaged.

Table 2.1 Cumberland County Ozone Monitor Design Values in parts per million (ppm)

Monitor Name	County	00-02	01-03
Wade	Cumberland	0.086	0.086
Golfview (Hope Mills)	Cumberland	0.087	0.087

Table 2.2 Historical 4th Highest 8-Hour ozone values (1994-2003)

Monitor Site	**4th Highest 8-Hour Ozone Values (ppm)**									
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Wade	0.084	0.081	0.086	0.085	0.093	0.100	0.086	0.080	0.094	0.086
Golfview	0.085	0.087	0.091	0.085	0.098	0.093	0.083	0.084	0.095	0.082

NCDAQ forecasts ozone levels on a daily basis from May 1 – September 30 for Fayetteville. This forecast is issued to the public using EPA's Air Quality Index (AQI) color code system. Table 2-3 lists the ozone regulatory standard and AQI breakpoints with their corresponding health risks.

Table 2-3: Air Quality Index Color Code System

		Pollutant concentration (ppm) ranges for AQI color codes				
Pollutant/ Standard	Standard Value	Green AQI 0– 50 Good	Yellow AQI 51-100 Moderate	Orange AQI 101-150 Unhealthy for Sensitive Groups	Red AQI 151-200 Unhealthy	Purple AQI 201-300 Very Unhealthy
Ozone/ 8-hour average	**0.08 ppm averaged over 8 hours**	**0-0.064**	**0.065-0.084**	**0.085-0.104**	**0.105-0.124**	**0.125-0.374**

The AQI color codes standardize the reporting of different pollutants by classifying pollutant concentrations according to relative health risk, using colors and index numbers to describe pollutant levels. The AQI is also used to report the previous day's air quality to the public. In the Fayetteville area, the forecast and previous day air quality reports appear on the weather page of local newspapers and NCDAQ's website: http://daq.state.nc.us/airaware/forecast. Additionally, the ozone forecast is broadcasted during the local news on television and radio.

3. Ozone And Its Health Effects And Sources

3.1 Overview of Ozone

Ozone (O_3) is a tri-atomic ion of oxygen. In the stratosphere or upper atmosphere, ozone occurs naturally and protects the Earth's surface from ultraviolet radiation. Ozone in the lower atmosphere is often called ground-level ozone, tropospheric ozone, or ozone pollution to distinguish is from upper-atmospheric or stratospheric ozone. Ozone does occur naturally in the lower atmosphere (troposphere), but only in relatively low background concentrations of about 30 parts per billion (ppb), well below the NAAQS. The term "smog" is also commonly used to refer to ozone pollution. Although ozone is a component of smog, smog is a combination of ozone and airborne particles having a brownish or dirty appearance. It is possible for ozone levels to be elevated even on clear days with no obvious "smog".

In the lower atmosphere, ozone is formed when airborne chemicals, primarily nitrogen oxides (NOx) and volatile organic compounds (VOCs), combine in a chemical reaction driven by heat and sunlight. These ozone-forming chemicals are called precursors to ozone. Man-made NOx and VOC precursors contribute to ozone concentrations above natural background levels. Since ozone formation is greatest on hot, sunny days with little wind, elevated ozone concentrations occur during the warm weather months, generally May through September. In agreement with EPA's guidance, North Carolina operates ozone monitors from April 1 through October 31 to be sure to capture all possible events of high ozone.

3.2 Ozone Health Effects

The form of oxygen we need to breathe is O_2. When we breathe ozone, it acts as an irritant to our lungs. Short-term, infrequent exposure to ozone can result in throat and eye irritation, difficulty drawing a deep breath, and coughing. Long-term and repeated exposure to ozone concentrations above the NAAQS can result in reduction of lung function as the cells lining the lungs are damaged. Repeated cycles of damage and healing may result in scarring of lung tissue and permanently reduced lung function. Health studies have indicated that high ambient ozone concentrations may impair lung function growth in children, resulting in reduced lung function in adulthood. In adults, ozone exposure may accelerate the natural decline in lung function that occurs as part of the normal aging process. Ozone may also aggravate chronic lung diseases such as emphysema and bronchitis and reduce the immune system's ability to fight off bacterial infections in the respiratory system.

Asthmatics and other individuals with respiratory disease are especially at risk from elevated ozone concentrations. Ozone can aggravate asthma, increasing the risk of asthma attacks that require a doctor's attention or the use of additional medication. According to the EPA, one reason for this increased risk is that ozone increases susceptibility to allergens, which are the most common triggers for asthma attacks. In addition, asthmatics are more severely affected by the reduced lung function and irritation that ozone causes in the respiratory system. There is increasing evidence that ozone may trigger, not just exacerbate, asthma attacks in some individuals. Ozone may also contribute to the development of asthma. A recent study published in the British medical journal *The Lancet* found a strong association between elevated ambient ozone levels and the development of asthma in physically active children.[2]

All children are at risk from ozone exposure because they often spend a large part of the summer playing outdoors, their lungs are still developing, they breathe more air per pound of body weight, and they are less likely to notice symptoms. Children and adults who frequently exercise outdoors are particularly vulnerable to ozone's negative health effects, because they may be repeatedly exposed to elevated ozone concentrations while breathing at an increased respiratory rate.[3]

3.3 Ozone Sources

Ozone-forming pollutants, or precursors, are nitrogen oxides (NOx) and volatile organic compounds (VOCs).

3.3.1 Volatile Organic Compounds

Volatile organic compounds (VOCs) are a class of hydrocarbons, and therefore are sometimes referred to as hydrocarbons. However, it is important to note that hydrocarbons, as a class of chemical compounds, include less-reactive compounds not considered VOCs. In other words, although all VOCs are hydrocarbons, not all hydrocarbons are VOCs.

In North Carolina, large portions of precursor VOCs are produced by natural, or biogenic, sources, which are primarily trees. Man-made, or anthropogenic, VOCs also contribute to ozone production, particularly in urban areas. Sources of anthropogenic VOCs include unburned gasoline fumes evaporating from gas stations and cars, industrial emissions, and consumer products such as paints, solvents, and the fragrances in personal care products.

3.3.2 Nitrogen Oxides

Nitrogen oxides (NOx) are produced when fuels are burned, and result from the reaction of atmospheric nitrogen at the high temperatures produced by burning fuels. Power plants, highway motor vehicles, the major contributor in urban areas, and off-road mobile source equipment, such as construction equipment, lawn care equipment, trains, boats, etc., are the major sources of NOx.

Other NOx sources include "area" sources (small, widely-distributed sources) such as fires (forest fires, backyard burning, house fires, etc.), and natural gas hot water heaters. Other residential combustion sources such as oil and natural gas furnaces and wood burning also produce NOx, but these sources generally do not operate during warm-weather months when ground-level ozone is a problem. In general, area sources contribute only a very small portion of ozone-forming NOx emissions.

Generally, North Carolina, including the Fayetteville area, is considered "NOx-limited" because of the abundance of VOC emissions from biogenic sources. Therefore, current ozone strategies focus on reducing NOx. However, VOC reduction strategies, such as control of evaporative emissions from gas stations and vehicles, could reduce ozone in urban areas where the biogenic VOC emissions are not as high.

3.3.3 Sources of NOx and VOCs

The following lists the sources, by category, that contribute to NOx and VOC emissions.

Biogenic: Trees and other natural sources.

Mobile: Vehicles traveling on paved roads: cars, trucks, buses, motorcycles, etc.

Nonroad: Vehicles not traveling on paved roads: construction, agricultural, and lawn care equipment, motorboats, locomotives, etc.

Point: "Smokestack" sources: industry and utilities.

Area: Sources not falling into above categories. For VOCs, includes gas stations, dry cleaners, print shops, consumer products, etc. For NOx, includes forest and residential fires, natural gas hot water heaters, etc.

4. Emissions Inventories

4.1 Description

Emissions modeling performed by NCDAQ estimates NOx and VOC emissions for an average summer day, given specific meteorological and future year conditions and using emission inputs based on emission inventories that include anticipated control measures. The biogenic emissions are kept at the same level as the episodic biogenic emissions since these emissions are based on meteorology and the meteorological conditions in the future years are kept the same as the episodic meteorology.

There are various types of emission inventories. The first is the base year or episodic inventory. This inventory is based on the year of the episode being modeled and is used for validating the photochemical model performance.

The second inventory used in this project is the “current” year inventory. For this modeling project it will be the 2000 emission inventory, which is the most current. This inventory is processed using all of the different meteorological episodes being studied. The photochemical modeling is processed using the current year inventory and those results are used as a representation of current air quality conditions for the meteorological conditions modeled.

Next is the future base year inventory. For this type, an inventory is developed for some future year for which attainment of the ozone standard is needed. The future base year projections for 2007 take into account all State and Federal control measures expected to operate at that time, including Federal vehicle emissions controls, NOx SIP Call controls, and North Carolina Clean Smokestacks controls. For this modeling project the attainment year is 2007 and the additional years for which a showing of continued maintenance of the 8-hour ozone standard are 2012 and 2017. An additional year, 2010, was modeled since this is the year for which the Charlotte/Gastonia and Raleigh/Durham areas must demonstrate attainment of the 8-hour ozone standard. It is the future base year inventories that control strategies and sensitivities are applied to determine what controls, to which source classifications must be made in order to attain the ozone standard.

The base year inventories used for each source classifications are discussed in Appendix D. In the sections that follow, the inventories used for the current and the future years are discussed. Emission summaries by county for 2000 and 2007 (entire State) are in Appendix A.

4.2 Current Year Inventories

For the large utility sources, year specific Continuous Emissions Monitoring (CEM) data is used for base year episode specific modeling. However, it did not make sense to use 2000 CEM data for the current year inventory since the meteorology used for the current year modeling runs are the 1995, 1996, and 1997 episode specific meteorology. The concern is that the utility day specific emissions for 2000 would not correspond to the meteorology used in the modeling. After discussing this issue with EPA, the decision was made to continue to use the episodic CEM data for the current year inventory. Since only CEM NOx emissions are reported to the EPA, Acid Rain Division (ARD), the CO and VOC emissions are calculated from the NOx emissions using emission factor ratios (CO/NOx and VOC/NOx) for the particular combustion processes at the utilities.

The inventory used to model the other point sources is the 1999 National Emissions Inventory (NEI) release version 2.0 obtained from the EPA's Clearinghouse for Inventories and Emission Factors (CHIEF) website (http://www.epa.gov/ttn/chief/net/1999inventory.html). In addition, North Carolina emissions for forest fires and prescribed burns are treated as point sources and are episode specific similar to CEM data. These emissions were kept the same as the episodic emissions.

Similar to the other point source emissions inventory, the inventory used to model the stationary area sources is the 1999 NEI release version 2.0 obtained from the EPA's CHIEF website. The exception to this is for North Carolina where a 2000 current year inventory was generated by NCDAQ following the current methodologies outlined in the Emissions Inventory Improvement Program (EIIP) Area Source Development Documents, Volume III (**http://www.epa.gov/ttn/chief/eiip/techreport/volume03/index.html**).

For the nonroad mobile sources that are calculated within the NONROAD mobile model, a 2000 current year inventory was generated for the entire domain. The model version used is the Draft NONROAD2002 distributed for a limited, confidential, and secure review in November 2002. A newer draft version of this model was released by the EPA in June, 2003. A comparison was done between the results from the two models and the differences were not significant for NOx emissions, however they were large for CO. Since CO does not play a large role in ozone formation, it is not believed that these differences will impact the ozone concentrations in the air quality model. However, since there are differences, when the final State Implementation Plan (SIP) modeling is carried out the updated emissions will be used.

The nonroad mobile sources not calculated within the NONROAD model include aircraft engines, railroad locomotives and commercial marine vessels. The 2000 current year inventory used for these sources is the 1999 NEI release version 2.0 obtained from the EPA's CHIEF website. The exception to this is for North Carolina where a 2000 current year inventory was generated by NCDAQ following the methodologies outlined in the EPA guidance document EPA-450/4-81-026d (Revised), Procedures for Inventory Preparation, Volume IV: Mobile Sources.

In order to accurately model the mobile source emissions in the EAC areas, the newest version of the MOBILE model, MOBILE6.2, was used. This model was released by EPA in 2002 and differs significantly from previous versions of the model. Key inputs for MOBILE include information on the age of vehicles on the roads, the speed of those vehicles, what types of road those vehicles are traveling on, any control technologies in place in an area to reduce emissions for motor vehicles (e.g., emissions inspection programs), and temperature. The development of these inputs is discussed in detail in Appendix D.

Biogenic emissions used in the 2000 current year modeling are the same as those used in the base year episodic modeling. This is due to the use of the same meteorology for the current year modeling runs. The development of this source category is discussed in Appendix D.

The emissions summary for the 2000 current year modeling inventories for the Fayetteville EAC area is listed in Table 4.2-1. These emissions represent typical weekday emissions and are reported in tons per day.

Table 4.2-1 2000 Current Year Modeling Emissions

Source	CO	NOX	VOC
Point	1	3	4
Area	6	0.5	12
Nonroad Mobile	59	7	5
Highway Mobile	197	28	18
Biogenic	0	0.4	46
Total Emissions	263	39	85

4.3 Future Year Inventories

The inventory used for the preliminary 2007 point source inventory is the EPA's May 1999 release of the NOx SIP call future year modeling foundation files, obtained from the EPA Office of Air Quality Planning and Standards (OAQPS). This is a 2007 emissions inventory, projected from a 1995 base year inventory and controlled in accordance to the NOx SIP call rule. The decision to use this inventory for initial 2007 future year modeling runs was made since all of the point sources required to have controls due to the NOx SIP call rule making are reflected in this inventory. The exception to this is for North Carolina. For the major North Carolina utility sources, NCDAQ obtained estimated future year hour specific data for the two largest utility companies within North Carolina, Duke Energy and Progress Energy. Additionally, the day specific forest fires and prescribed fires inventory were the episodic emissions.

The final modeling run for the 2007 future year point source inventory uses the EPA's 1999 NEI inventory grown to 2007 using growth factors from the EPA's Economic Growth Analysis System (EGAS) version 4.0. The exception to this is for North Carolina, where State specific growth factors, and where available source specific growth factors, were used to grow the North Carolina 1999 inventory. Additionally, NCDAQ created a new control file that reflect how the states surrounding North Carolina plan to implement the NOx SIP call rule as well as all other rules that are on the books. The 2012 future year point source inventory was generated using this same methodology.

The inventory used to model the stationary area sources for 2007 and 2012 is the 1999 NEI release version 2.0 obtained from the EPA's CHIEF website and were grown to 2007 using growth factors from the EPA's Economic Growth Analysis System (EGAS) version 4.0. The exception to this is for North Carolina, where the 2000 current year inventory was grown using a mixture of EGAS growth factors and state-specific growth factors for the furniture industry.
For the nonroad mobile sources that are calculated within the NONROAD mobile model, a 2007 and 2012 future years inventories were generated for the entire domain using the same model used to generate the current year inventory. In the final modeling, the NONROAD2002a model will be used to create the nonroad inventory. The remaining nonroad mobile source categories, the 1999 NEI release version 2.0 obtained from the EPA's CHIEF website and were grown to

2007 and 2012 using growth factors from the EPA's Economic Growth Analysis System (EGAS) version 4.0. The exception to this is for North Carolina, where the 2000 current year inventory was grown with EGAS growth factors.

The same MOBILE model was used to create the 2007 and 2012 future years highway mobile source inventories. The vehicle miles traveled (VMT) were projected using the methodologies prescribed by EPA. The exception to this was for North Carolina. In the urban areas of North Carolina VMT from travel demand models (TDM) for future years was available. The future years VMT were estimated by interpolating between the TDM future year estimates. Additionally, estimated future year speeds were obtained from the North Carolina Department of Transportation (NCDOT).

Biogenic emissions used in the future years modeling are the same as those used in the base year episodic modeling. This is due to the use of the same meteorology for the future year modeling runs. The development of this source category is discussed in Appendix D.

The emissions summary for the 2007 and 2012 future years modeling inventories for the Fayetteville EAC area is listed in Table 4.3-1. These emissions represent typical weekday emissions and are reported in tons per day.

Table 4.3-1 Future Year Modeling Emissions

Source	2007			2012		
	CO	NOX	VOC	CO	NOX	VOC
Point	1	4	7	1	3	4
Area	7	0.5	12	7	0.6	13
Nonroad Mobile	68	6	4	68	5	3
Highway Mobile	108	19	10	81	11	8
Biogenic	0.0	0.4	46	0	0.4	46
Total Emissions	184	30	79	157	20	74

Note that in the maintenance year 2012 the emissions are expected to be lower than the attainment year 2007, therefore continued maintenance of the 8-hour ozone standard is expected.

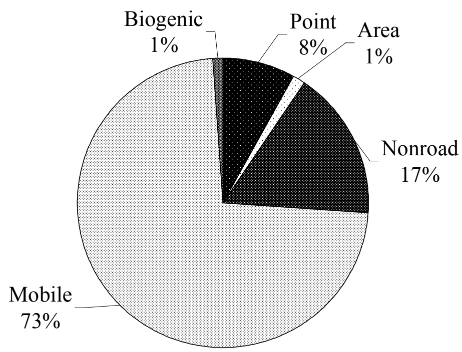
4.4 Comparison of 2000 and 2007 Inventories

The total predicted NOx emissions for Cumberland County decreased by 25%, from 39 tons per day (TPD) in 2000 to 30 TPD in 2007. This data is tabulated in Table 4.4-1. This same data is displayed in Figures 4.4-1 and 4.4-2 as pie charts with the percent contribution by each source category.

Table 4.4-1: Estimated NOx and VOC emissions, in tons per day

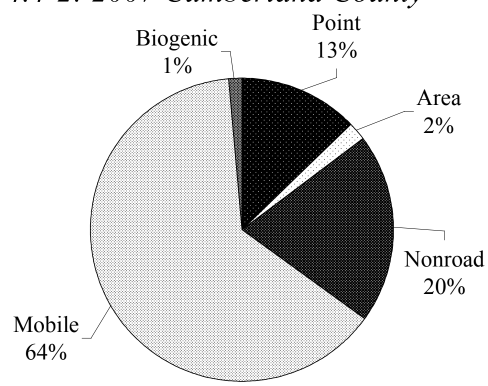
Source	NOx Emissions		VOC Emissions	
	2000	2007	2000	2007
Point	3	4	4	7
Area	0.5	0.5	12	12
Nonroad	7	6	5	4
Mobile	28	19	18	10
Biogenic	0.4	0.4	46	46
Total Emissions	2039	2037	2085	2086

Figure 4.4-1: 2000 Cumberland County



NOx Emissions by Source

Figure 4.4-2: 2007 Cumberland County



NOx Emissions by Source

The total predicted VOC emissions for Cumberland County decreased by 7%, from 85 TPD in 2000 to 79 TPD in 2007. This data is also tabulated in Table 4.4-1. This same data is displayed in Figures 4.4-3 and 4.4-4 as pie charts with the percent contribution by each source category. The percent of each source category

Figure 4.4-3: 2000 Cumberland County VOC Emissions by Source

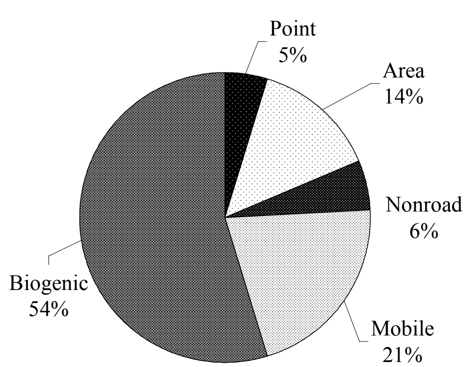
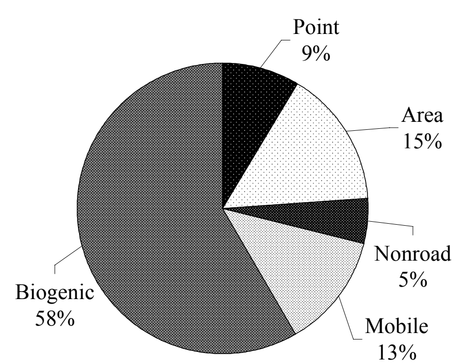


Figure 4.4-4: 2007 Cumberland County VOC Emissions by Source



There are few control measures expected for area and point sources in Cumberland County, so they continue to grow, however, there are significant decreases in highway and nonroad mobile source emissions to produce an overall decrease in both NOx and VOC emissions.

For both, highway and nonroad mobile sources, diesel vehicles contribute the majority of NOx emissions. Figures 4.4-5 and 4.4-6 show the relative contributions of vehicle types for the highway mobile source category in 2000 and 2007 for Cumberland County. As shown in these figures, the relative contributions from vehicle types do not change greatly between 2000 and 2007. The estimated emissions for each vehicle type are tabulated in Table 4.4-2.

Figure 4.4-5: 2000 Cumberland County
Highway Mobile NOx Sources

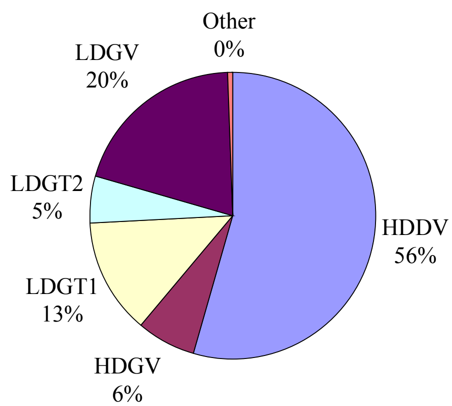
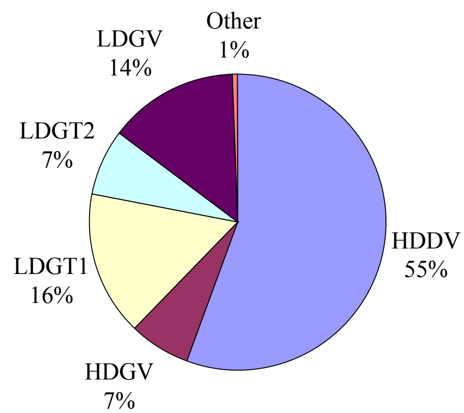


Figure 4.4-6: 2007 Cumberland County
Highway Mobile NOx Sources



HDDV = Heavy-duty diesel vehicles (trucks)
HDGV = Heavy-duty gasoline vehicles (trucks)
LDGT (1&2) = Light-duty gasoline trucks
LDGV = Light-duty gasoline vehicles
Other = Motorcycles, light-duty diesel vehicles & trucks

Table 4.4-2: Estimated Highway NOx Emissions, by vehicle type

Source	NOx Emissions in TPD	
	2000	2007
Heavy-duty diesel vehicles	15.5	10.3
Light-duty gasoline vehicles	5.8	2.7
Light-duty gasoline trucks (1)	3.7	2.9
Light-duty gasoline trucks (2)	1.5	1.3
Heavy-duty gasoline vehicles	1.8	1.3
Other	0.1	0.1
Total	28.4	18.6

Figures 4.4-7 and 4.4-8 show the relative contributions of equipment types for the nonroad mobile source category in 2000 and 2007 for Cumberland County. As can be seen in these figures, diesel construction equipment contributes about half of nonroad mobile source NOx for both years.

Figure 4.4-3: 2000 Cumberland County Nonroad NOx sources

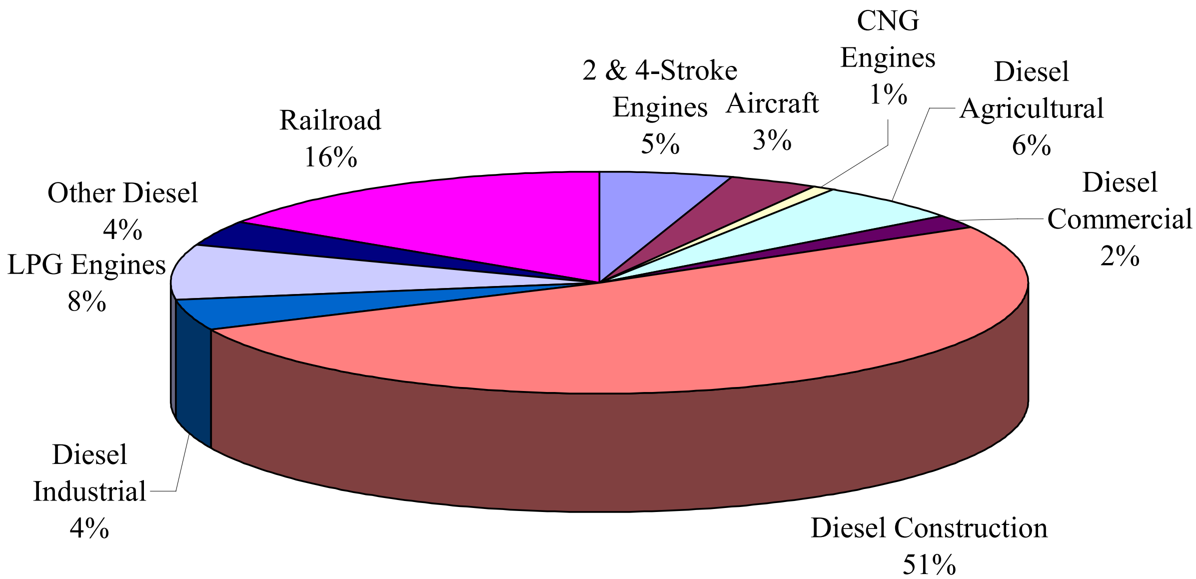
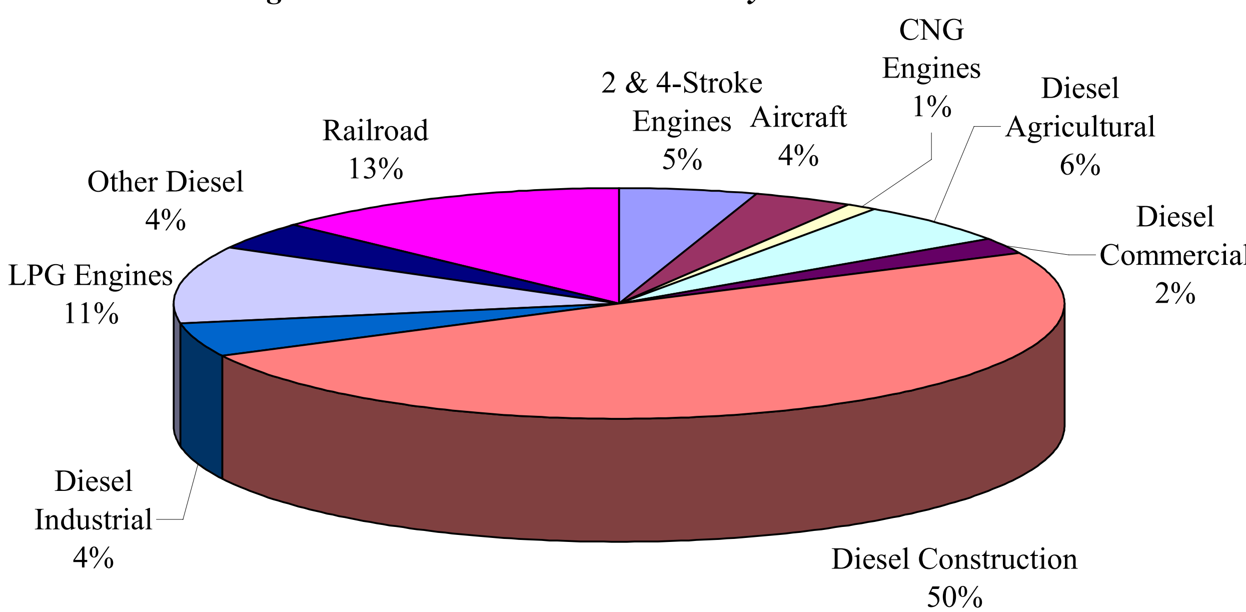


Figure 4.4-4: 2007 Cumberland County Nonroad NOx sources



4.5 Comparison of 2000 and 2010 Inventories

North Carolina developed the 2010 future year emissions inventory as an intermediate year between 2007, where attainment of the 8-hr Ozone standard is to be demonstrated, and 2012 where continued maintenance of the standard is required. This year was chosen since it is the year that the Charlotte/Gastonia and Raleigh/Durham areas must show attainment of the 8-hour ozone standard.

The inventory used for the 2010 point source inventory is EPA's 2010 emission inventory used for their heavy-duty diesel rule making. The decision to use this inventory for the 2010 future year modeling runs was made since all of the point sources required to have controls due to the NOx SIP call rule making are reflected in this inventory. The exception to this is for North Carolina. For the major North Carolina utility sources, NCDAQ obtained estimated future year hour specific data for the two largest utility companies within North Carolina, Duke Energy and Progress Energy. Additionally, the day specific forest fires and prescribed fires inventory were the episodic emissions.

The inventory used to model the stationary area sources is also the EPA's emission inventory used for the heavy-duty diesel engine rule making. The exception to this is for North Carolina, where the 2000 current year inventory was grown using a mixture of EGAS growth factors and state-specific growth factors for the furniture industry.

For the nonroad mobile sources that are calculated within the NONROAD mobile model, a 2010 future year inventory was generated for the entire domain using the same model used to generate the current year inventory. The remaining nonroad mobile source categories, EPA's 2010 emission inventory used for their heavy-duty diesel engine rule making was used.

The same MOBILE model was used to create the 2010 future year highway mobile source inventory. The vehicle miles traveled (VMT) were projected using the methodologies prescribed by EPA. The exception to this was for North Carolina. In the urban areas of North Carolina VMT from travel demand models (TDM) for future years was available. The 2010 VMT was estimated by interpolating between the TDM future year estimates. Additionally, estimated future year speeds were obtained from the North Carolina Department of Transportation (NCDOT).

Biogenic emissions used in the 2010 future year modeling are the same as those used in the base year episodic modeling. This is due to the use of the same meteorology for the future year modeling runs.

The emissions summary for the 2010 future year modeling inventories for the Fayetteville EAC area is listed in Table 4.5-1. These emissions represent typical weekday emissions and are reported in tons per day.

Table 4.5-1: Estimated NOx and VOC emissions, in tons per day

Source	NOx Emissions			VOC Emissions		
	2000	2007	2010	2000	2007	2010
Point	3	4	3	4	7	1
Area	0.5	0.5	0.5	12	12	12
Nonroad	7	6	7	5	4	8
Mobile	28	19	12	18	10	8
Biogenic	0.4	0.4	0.4	46	46	46
Total Emissions	2039	2037	23	2085	2086	75

The total predicted NOx emissions for the Fayetteville area decreased by ~41%, from 39 tons per day (TPD) in 2000 to 23 TPD in 2010. The total predicted VOC emissions for the Fayetteville area decreased by ~12%, from 85 TPD in 2000 to 75 TPD in 2010. The 2010 highway mobile source emissions show a continuing decrease even from the 2007 emission levels for both NOx and VOC. The difference in the point source VOC emissions is believed to be an artifact of the differences between the EPA point source inventories used in the modeling. In future modeling runs a consistent North Carolina inventory will be used and grown using State specific growth factors instead of relying on EPA's future year inventories.

4.6 2017 Future Year Inventory

The State is in the process of developing the 2017 future year emission inventory for purposes of showing continued maintenance of the 8-hour ozone standard. The air quality modeling runs will be completed in the next couple of months and will be part of the final State submittal in December 2004.

5. Control Measures

Several control measures, already in place or being implemented over the next few years, will reduce point, highway mobile, and nonroad mobile sources emissions. State and federal control measures were modeled for 2007, and are discussed in the Sections below.

5.1 Local EAC Control Measures

Through the Stakeholders' and Public involvement process, the Fayetteville Metropolitan Statistical Area submitted to all of the County's jurisdictions and Fort Bragg a list of proposed strategies to be implemented in the efforts to decrease NOx and VOC emissions.

While reviewing the strategies to be implemented, the Early Action Compact and Milestones were carefully reviewed. This area is very supportive of this process and wishes for a healthful environment for its citizens and a high quality of life. Logistically, many of the strategies that could be selected and implemented require more time to develop and enforce than the two years outlined in the Milestones of the EAC. For this reason some of the following strategies have a deadline of December 2005, whereas efforts to develop new or amended ordinances and documents are already on-going. It is the hope of all of the jurisdictions within the Fayetteville MSA that several Strategies will be implemented and enforced during this year, however, knowing that ordinances and new program implementations take time, we will maintain the December 2005 deadline, to assure that all of our efforts will be fully completed by the deadline.

Upon implementation of the strategies, the EAC binds local areas to submit semi-annual reports to the EPA until 2007 and to perform modeling for the year 2012. The EAC signed by this area includes modeling for the year 2017, ten years after designation.

The Fayetteville MSA will continue to monitor and report on accomplishments beyond 2007 and will compile and submit such report during the review and update of the MPOs Long Range Transportation Plan, whether required every five years, as currently set, or every three years, if modified in the Reauthorization of TEA-21, the current Transportation Bill, to the year 2019.

AIR QUALITY STAKEHOLDERS OF CUMBERLAND COUNTY
SELECTED OZONE CONTROL STRATEGIES AND IMPLEMENTATION SCHEDULE

STRATEGY	STRATEGY DESCRIPTION	ESTIMATE OF NOX REDUCTIONS (if available)	DRAFT IMPLEMENTATION DATE	ADOPTING JURISDICTIONS
LAND USE				
Landscape Ordinance	Require landscaping of major nonresidential developments within the MSA, including retrofitting older developments	It is believed that this strategy will lower NO_X emissions. The emission reductions are not currently quantifiable, but this strategy is directionally correct.	**December 2005** – County-wide **December 2003** – Fort Bragg implements the Sustainable Installation Design Guide.	Cumberland County City of Fayetteville Falcon Godwin Hope Mills Linden Spring Lake Stedman Wade Fort Bragg
Conduct a Smart Growth Audit	Conduct a benchmark land use assessment and compare it with Smart Growth policies. To complete in conjunction with new Zoning Ordinance and Land Use Plans	It is believed that this strategy will lower NO_X emissions. The emission reductions are not currently quantifiable, but this strategy is directionally correct.	**December 2005**	Cumberland County City of Fayetteville Falcon Godwin Hope Mills Linden Spring Lake Stedman Wade

STRATEGY	STRATEGY DESCRIPTION	ESTIMATE OF NOX REDUCTIONS (if available)	IMPLEMENTATION DATE	ADOPTING JURISDICTIONS
LAND USE				
Transit/Pedestrian/Mixed Use Oriented Development	Add a mixed-use alternative to zoning ordinance along transit lines and include sidewalks, shade trees, benches, and landscaping as well as bike paths/lanes, which will increase the desirability of walking and biking and promote the use of transit. Work with schools and parks to facilitate pedestrian crossing from subdivisions to schools. Fort Bragg is building upon existing mixed used development by adding pedestrian trails and sidewalks.	NO QUANTIFICATION-base line and extensive study would be required to obtain NOx emission reductions for Cumberland County. NOx reductions are supported by the Portland, Oregon study cited on Page 26 of "Improving Air Quality Through Land Use Activities" www.epa.gov/otaq/transp/landguid.htm Portland Oregon study supports 8% decrease in VMT and NOX emissions decrease of 6%.	**December 2005** **Ongoing at Fort Bragg**	Cumberland County City of Fayetteville Falcon Godwin Hope Mills Linden Spring Lake Stedman Wade Fort Bragg
Infill Development	Promote infill and brownfield development in urban areas, to utilize existing infrastructure and to decrease and/or maintain VMTs. Strengthening the downtown area. Economic Incentives are available for businesses in the downtown area through the Downtown Loan Program and Historic Properties, a public/private partnership.	It is believed that this strategy will lower NO_X emissions by decreasing VMT (promotes Pedestrian Transit and Mass Transit Use). The emission reductions are not currently quantifiable, but this strategy is directionally correct.	**Ongoing** City of Fayetteville allows Zero Lot Line Subdivision Development encouraging infill development. Fort Bragg will continue to redevelop existing urban land use. The majority of projects are built on the currently developed sites instead of new, undisturbed sites.	Cumberland County City of Fayetteville Falcon Godwin Hope Mills Linden Spring Lake Stedman Wade Fort Bragg

STRATEGY	STRATEGY DESCRIPTION	ESTIMATE OF NOX REDUCTIONS (if available)	IMPLEMENTATION DATE	ADOPTING JURISDICTIONS
LAND USE				
Shared Parking Facilities and Connectivity	This will reduce the amount of impervious surface, which contributes to the heat island effect and reduces the amount of stop and go traffic.	It is believed that this strategy will lower NO_X emissions by decreasing VMT. The emission reductions are not currently quantifiable, but this strategy is directionally correct.	**December 2005**	Cumberland County City of Fayetteville Falcon Godwin Hope Mills Linden Spring Lake Stedman Wade
Urban Reforestation/ Green Space	Public Works Commission has policies to maintain tree coverage in watershed areas and seek to expand land acquisition for preservation of the watershed. NC Forest Services is seeking grant funding to plant at least 100 trees. Cumberland County to complete a public green space inventory of the entire county. Conservation Subdivision Option	It is believed that this strategy will lower NO_X emissions by reducing the heat island affect. The emission reductions are not currently quantifiable, but this strategy is directionally correct.	**Ongoing** **Ongoing** **March 2004** **Under Investigation**	Cumberland County City of Fayetteville Falcon Godwin Hope Mills Linden Spring Lake Stedman Wade

The following is from the EPA Air and Radiation Office of Transportation and Air Quality "Improving Air Quality Through Land Use Activities", EPA420-R-01-001, January 2001.

The physical characteristics and patterns of land development in a region can affect air quality by influencing the travel mode choices citizens have available to them. Development patterns that locate jobs, housing and recreation in closer proximity to each other, can mean shorter and fewer car and truck trips, thus reducing vehicle miles traveled (VMT) and likely reducing motor vehicle emissions. Other development patterns have the potential to improve or mitigate air quality problems by providing and promoting alternatives to vehicular travel, such as mass transit, walking, or biking. The most significant urban form features that can affect travel activity are:

- *Density = infill*
- *Land Use Mix – incorporating different land uses (e.g. recreation, housing, employment, shopping) with a development, a neighborhood, or a region.*

- *Transit Accessibility – locating high-density commercial and residential development around transit stations, also known as "transit oriented development," or TOD.*
- *Pedestrian-Environment/ Urban Design Factors – features that improve the pedestrian environment such as sidewalks, clearly marked crosswalks, shade trees, benches, and landscaping; also refers to features that improve the bicycling environment such as bike paths and dedicated bike lanes, bike parking and clear signs.*
- *Regional Patterns of Development – patterns of dispersion, centralization, or clustering of activities within a metropolitan area, as well as the relationship of development to highway and transit systems; involves the interrelationships between employment and residential development and the transportation connection between sets of origin and destination points*

The air quality impacts of land use activities on transportation depend on numerous factors, including density and location of development, amount of development, mix of uses, and access to transportation alternatives. The interaction of these factors is complex, and due to the variations from one development project to another, each development needs to be analyzed individually. Studies have been conducted in Portland, Oregon; Sacramento and Los Angeles, California; Baltimore, Maryland; and Washington, DC that support VMT reduction associated with land use strategies over a 20 year time horizon.

STRATEGY	STRATEGY DESCRIPTION	ESTIMATE OF NOX REDUCTIONS (if available)	IMPLEMENTATION DATE	ADOPTING JURISDICTIONS
MOBILE SOURCES				
Alternative Fuels and AF Vehicles	Fort Bragg has developed a plant to convert its fleet to Bio-Diesel 20 and Ethanol E85. This project includes an AF fueling station. 185 vehicles will be converted to B20 (100,000 gallons of diesel fuel). 158 Flexible Fuel vehicles to use approximately 55,000 gallons of E85 per year.	CACPS was used to get these approximate reductions: VOC = 326 lbs. Per year This strategy shows a slight increase in NOx emissions (102 lbs./yr), however it also shows reductions in all other pollutants and PM, which could be a potential problem for this area NOx = 2261 lbs. Per year VOC = 3261 lbs. Per year	**December 2005**	Fort Bragg
Idling Restrictions	Festival Park will include electrical outlets for use to reduce truck idling during festivals.	It is expected that this project will decrease NOx emissions. Emission reductions will be quantified upon project completion and based upon events scheduled.	**October 2005**	City of Fayetteville Falcon Godwin Linden Stedman Wade
Retrofitting Diesel School Buses	Fort Bragg has received a grant to fund retrofitting of school buses serving the Fort Bragg Schools.	It is expected that this project will decrease NOx emissions.	**Summer 2004**	Fort Bragg

The Fayetteville MSA reviewed many AF and AFV possibilities, but, because the infrastructure is not in place at this time and developing it would be cost prohibitive and it could not be implemented by December 2005, no other governments agreed to participate. Mobile source strategies will be reviewed and evaluated for long range planning in this area.

AIR QUALITY STAKEHOLDERS OF CUMBERLAND COUNTY
SELECTED OZONE CONTROL STRATEGIES AND IMPLEMENTATION SCHEDULE

STRATEGY	STRATEGY DESCRIPTION	ESTIMATE OF NOX REDUCTIONS (if available)	IMPLEMENTATION DATE	ADOPTING JURISDICTIONS
TRANSPORTATION				
Using Intelligent Transportation Systems (ITS) and Dynamic Message Signs (DMS) for Congestion Management and Ozone Alerts	Project U-3635 Closed Loop Signal System will provide a new area-wide closed loop signal system. Dynamic Message Signs will be installed at congested intersections/corridors. Expansion of existing continuous flow right turn lanes in the urbanized area.	It is expected that this project will decrease NOx emissions by decreasing traffic congestion. It is currently difficult to quantify this effort, however other examples of this system have shown anywhere from 0-20% reductions in traffic congestion resulting in less idling, travel time, and, as a result, NOx	**2004** is expected completion year for Project U-3635.	Cumberland County City of Fayetteville Hope Mills
Enhance Mass Transit System	Redesign routes to be more convenient to riders. Increase frequency of transit services to 15 minutes. Fort Bragg initiated a shuttle service providing service around the post and connecting with municipal transit.	CACPS was used to get an approximate reduction: VOC = 17,698 lbs per year NOx = 5,533 lbs per year CACPS was used to get an approximate reduction: VOC = 147 lbs per year NOx = 54 lbs per year	**December 2005 - FAST** **Ongoing – Fort Bragg**	City of Fayetteville Fort Bragg
Formulate Car and Van Pooling Increase Rural Transportation Paratransit	Development of Database to connect riders. Vanpooling and carpooling programs are being advertised by transit provider. Rural transportation is currently being expanded to connect outlying areas of the county and smaller municipalities.	It is believed that this strategy will lower NO_X emissions. Quantification will be provided when implemented.	**December 2004**	City of Fayetteville Falcon Godwin Stedman Wade

STRATEGY	STRATEGY DESCRIPTION	ESTIMATE OF NOX REDUCTIONS (if available)	IMPLEMENTATION DATE	ADOPTING JURISDICTIONS
TRANSPORTATION				
Encourage Park and Ride for Large Events	FAST and Private Transportation providers (i.e. Festival of Flight) are providing shuttle at nominal cost to public. For Bragg provides internal transportation services for large on-post events at no cost to the rider.	Emission reductions will be quantified for each event and included in semi-annual updates.	**Ongoing**	City of Fayetteville Fort Bragg

STRATEGY	STRATEGY DESCRIPTION	ESTIMATE OF NOX REDUCTIONS (if available)	IMPLEMENTATION DATE	ADOPTING JURISDICTIONS
CONSERVATION				
Use renewable energy sources when available (i.e. solar and methane)	Cumberland County Landfill harvests methane and through a contract with Biomass Energy, sells the energy to Cargill Inc., a local industry. Cargill Inc. is using 1000 cubic feet/minute of landfill gas. Biomass Energy estimates that this usage can be increased to 1600 cubic feet/minute over the next 4-5 years. Encourage residents and businesses to support NC Green Power, a nonprofit program working to encourage development of renewable energy sources. A $4.00 contribution purchases one block of green power (equivalent to 100 kilowatt-hours).	Estimated NOx reduction = 5 tons per year. AP42, Table 2.4-5 was used to obtain emission reduction estimates. NOx savings were approximated using the flare NOx emission rate of 40 lb/million cubic feet, 252 million cubic feet/min of landfill gas usage (which is 600 cubic feet/minute multiplied by 7000 operating hours per year). Update: Working with NC Green Power to obtain the number of blocks of green power purchased by Cumberland County Residents.	**Ongoing** **Spring 2004** – Promote during AQ outreach, include link on County website.	Cumberland County Countywide
Retrofitting of public buildings. Encourage construction of energy efficient buildings.	Through the "Guaranteed Energy Savings Contract", the County will engage a company to evaluate and upgrade buildings equipment and material to increase energy efficiency. PWC is a member of the "Good Cents" Housing Program. Participating builders receive heat pump rebates and free listing of energy efficient homes for sale in the local newspaper and on the PWC website. Smaller municipalities are also promoting the "Good Cents" Housing Program. Fort Bragg is currently implementing energy reduction per Executive Order 13123 and as part of its Sustainability Plan by partnering with Honeywell Corporation to retrofit buildings on Fort Bragg (replacing inefficient interior/ exterior lighting, installing new HVAC systems with energy controls for optimum building performance. Fort Bragg also constructs new homes and retrofits older homes to meet "ENERGY STAR" standards.	It is believed that this strategy will lower NO_X emissions by reducing the output needed from fossil fuel plants to heat and cool homes and public building. We are still trying to quantify emission reductions, but feel this strategy is directionally correct.	**December 2004** – "Guaranteed Energy Savings Contract" **Ongoing** – Promotion of "Good Cents" Housing Program **Ongoing** – Fort Bragg	Cumberland County City of Fayetteville Falcon Godwin Linden Spring Lake Stedman Wade Fort Bragg

AIR QUALITY STAKEHOLDERS OF CUMBERLAND COUNTY
SELECTED OZONE CONTROL STRATEGIES AND IMPLEMENTATION SCHEDULE

STRATEGY	STRATEGY DESCRIPTION	ESTIMATE OF NOX REDUCTIONS (if available)	IMPLEMENTATION DATE	ADOPTING JURISDICTIONS
CONSERVATION				
Encourage Construction and Use of Energy Efficient Equipment. Promote Purchase of "Green"/ less polluting products.	Fort Bragg is implementing energy reduction strategies including low NOX burners in new major emission sources, is increasing the use of water-based paints to reduce VOC emissions and has installed a paint booth which uses only water-based paint, and is researching alternatives to replace two incinerators.	These strategies will lower NOx and VOC emissions. Research efforts will include emission reductions.	**Ongoing** – specified under current contract. **Summer 2004** –initiate research on alternatives for the incinerators.	Fort Bragg.

Landfill gas-to-energy projects provide environmental value by capturing methane emissions from landfills and displacing fossil fuel. Landfill gas is an attractive renewable energy alternative for many applications because of its 24 X 7 availability and high capacity factor (between 95 and 98%).

Burning landfill gas converts methane into carbon dioxide, and therefore dramatically reduces the impact on climate change by reducing greenhouse gas (GHG) emissions. Landfill gas (LFG) procurement is both an opportunity for corporations to reduce their GHG emissions footprint and to create a more diversified energy portfolio.

The World Resources Institute published a report, *Corporate Guide to Green Power Markets*. "Opportunities with Landfill Gas" is Installment 2 of this report. The Group has found that the most environmentally and economically attractive use of landfill gas, particularly in the absence of policy incentives such as production tax credits, is a medium-Btu "direct use" application, which Cargill, Inc. is currently using.

AIR QUALITY STAKEHOLDERS OF CUMBERLAND COUNTY
SELECTED OZONE CONTROL STRATEGIES AND IMPLEMENTATION SCHEDULE

STRATEGY	STRATEGY DESCRIPTION	ESTIMATE OF NOX REDUCTIONS (if available)	IMPLEMENTATION DATE	ADOPTING JURISDICTIONS
AWARENESS				
Student Outreach through Education Systems	Ongoing effort using the "GLOBE" program, a worldwide hands-on, primary and secondary school-based educational science program. This is a cooperative effort, led in the US by a federal interagency program supported by NASA (National Aeronautics & Space Administration), NSF (National Science Foundation), EPA (Environmental Protection Agency) and the U.S. State Department. There are currently 9,000 teachers in our area who are trained and present the program that promotes environmental stewardship and research. Staff, Air Quality Stakeholders, and Technical Committee members are also providing classroom presentations upon request.	It is believed that this strategy will lower NO_X emissions. The emission reductions are not currently quantifiable, but this strategy is directionally correct.	**Ongoing**	Cumberland County City of Fayetteville Falcon Godwin Linden Stedman Wade
Public Education/Outreach at Community Events & Churches	Ongoing effort through the Speakers Bureau. Staff and volunteers participate in festivals, fairs, community meetings, etc to provide information on air quality and the individual measures that can be taken to improve the air we breathe.	It is believed that this strategy will lower NO_X emissions. The emission reductions are not currently quantifiable, but this strategy is directionally correct.	**Ongoing**	Cumberland County City of Fayetteville Falcon Godwin Linden Spring Lake Stedman Wade
Speakers Bureau	Participation in radio/television programs to reach the general public with air quality information and tips, advertise meetings and involve the local newspapers and churches in disseminating information to increase public awareness and participation in implementing voluntary reduction strategies.	It is believed that this strategy will lower NO_X emissions. The emission reductions are not currently quantifiable, but this strategy is directionally correct.	**Ongoing**	Cumberland County City of Fayetteville Falcon Godwin Linden Spring Lake Stedman Wade
Air Quality Web Page	Maintained and updated by FAMPO (Fayetteville Metropolitan Planning Organization). Provides information on upcoming meetings, seasonal air quality tips, the Early Action Compact program and other relevant topics.	It is believed that this strategy will lower NO_X emissions. This strategy is directionally correct.	**Ongoing**	Cumberland County for all participating agencies

AIR QUALITY STAKEHOLDERS OF CUMBERLAND COUNTY
SELECTED OZONE CONTROL STRATEGIES AND IMPLEMENTATION SCHEDULE

STRATEGY	STRATEGY DESCRIPTION	ESTIMATE OF NOX REDUCTIONS (if available)	IMPLEMENTATION DATE	ADOPTING JURISDICTIONS
AWARENESS				
Promote Bus Ridership for Youth	Fayetteville Area System of Transit (FAST) is promoting bus tours for children of all ages, educating them on how to use the transit system and the benefits of using transit (including air quality and health issues). Various organizations have tours for groups (i.e. Boys and Girls Club) that include giving them free bus passes.	It is believed that this strategy will lower NO_X emissions by increasing future mass transit use and decreasing VMT. The emission reductions are not currently quantifiable, but this strategy is directionally correct.	**Ongoing**	City of Fayetteville
Air Quality Educational System at the local libraries.	Air Quality handouts and flyers available at all branches. Children's summer program.	It is believed that this strategy will lower NO_X emissions. The emission reductions are not likely quantifiable, but this strategy is directionally correct.	**Ongoing** **Summer of 2004**	Cumberland County for all participating agencies
Air Quality poster/essay contest for schools.	Air Quality related contest to raise air awareness.	It is believed that this strategy will lower NO_X emissions. The emission reductions are not likely quantifiable, but this strategy is directionally correct.	**Ongoing** (public schools) **Spring 2005** (public and private schools)	Cumberland County for all participating agencies Fort Bragg
Discourage Open Burning on Ozone Alert Days (orange or above)	Representation on OBOT (NC DAQ Open Burning Outreach Team). Will assist NCDAQ in distributing outreach material targeted to reduce open burning.	It is believed that this strategy will lower NO_X emissions. The emission reductions are not likely quantifiable, but this strategy is directionally correct. OBOT will provide materials for public outreach efforts.	**Ongoing**	Cumberland County City of Fayetteville Falcon Godwin Linden Spring Lake Stedman Wade

5.2 State Control Measures

5.2.1 Clean Air Bill

The 1999 Clean Air Bill expanded the vehicle emissions inspection and maintenance program from 9 counties to 48, and improved the testing method. Vehicles are being tested using the onboard diagnostic system, which indicates NOx emissions, among other pollutants. The previously used tailpipe test did not measure NOx. The inspection and maintenance program was instituted in Cumberland County on July 1, 2003 and is quantifiable and enforceable. This is not a federally mandated program therefore we take credit for it in the SIP and it results to a 4% of mobile NOx reduction in Cumberland County.

5.2.2 NOx SIP Call Rule

North Carolina's NOx SIP Call rule will reduce summertime NOx emissions from power plants and other industries by 68% by 2006. The North Carolina Environmental Management Commission adopted rules requiring the reductions in October 2000.

5.2.3 Clean Smokestacks Act

In June 2002, the N.C. General Assembly enacted the Clean Smokestacks Act, requiring coal-fired power plants to reduce annual NOx emissions by 78% by 2009. These power plants must also reduce annual sulfur dioxide emissions by 49% by 2009 and by 74% in 2013. The Clean Smokestacks Act could potentially reduce NOx emissions beyond the requirements of the NOx SIP Call Rule. One of the first state laws of its kind in the nation, this legislation provides a model for other states in controlling multiple air pollutants from old coal-fired power plants.

5.2.4 Open Burning Bans

In June 2004, the Environmental Management Commission should approve a new rule that would ban open burning during the ozone season on code orange and code red ozone action days for those counties that NCDAQ forecasts ozone. NCDAQ will determine what rule penetration and rule effectiveness would be most appropriate to use for this rule.

5.3 Federal Control Measures

5.3.1 Tier 2 Vehicle Standards

Federal Tier 2 vehicle standards will require all passenger vehicles in a manufacturer's fleet, including light-duty trucks and Sports Utility Vehicles (SUVs), to meet an average standard of 0.07 grams of NOx per mile. Implementation will begin in 2004, and most vehicles will be phased in by 2007. Tier 2 standards will also cover passenger vehicles over 8,500 pounds gross vehicle weight rating (the larger pickup trucks and SUVs), which are not covered by current Tier 1 regulations. For these vehicles, the standards will be phased in beginning in 2008, with full compliance in 2009. The new standards require vehicles to be 77% to 95% cleaner than those on the road today. Tier 2 rules will also reduce the sulfur content of gasoline to 30 ppm by 2006. Most gasoline currently sold in North Carolina has a sulfur content of about 300 ppm. Sulfur occurs naturally in gasoline but interferes with the operation of catalytic converters in vehicle engines resulting in higher NOx emissions. Lower-sulfur gasoline is necessary to achieve Tier 2 vehicle emission standards.

5.3.2 Heavy-Duty Gasoline and Diesel Highway Vehicles Standards

New EPA standards designed to reduce NOx and VOC emissions from heavy-duty gasoline and diesel highway vehicles will begin to take effect in 2004. A second phase of standards and testing procedures, beginning in 2007, will reduce particulate matter from heavy-duty highway engines, and will also reduce highway diesel fuel sulfur content to 15 ppm since the sulfur damages emission control devices. The total program is expected to achieve a 90% reduction in PM emissions and a 95% reduction in NOx emissions for these new engines using low sulfur diesel, compared to existing engines using higher-content sulfur diesel.

5.3.3 Large Nonroad Diesel Engines Proposed Rule

The EPA has proposed new rules for large nonroad diesel engines, such as those used in construction, agricultural, and industrial equipment, to be phased in between 2008 and 2014. The proposed rules would also reduce the allowable sulfur in nonroad diesel fuel by over 99%. Nonroad diesel fuel currently averages about 3,400 ppm sulfur. The proposed rules limit nonroad diesel sulfur content to 500 ppm in 2007 and 15 ppm in 2010. The combined engine and fuel rules would reduce NOx and particulate matter emissions from large nonroad diesel engines by over 90 %, compared to current nonroad engines using higher-content sulfur diesel.

5.3.4 Nonroad Spark-Ignition Engines and Recreational Engines Standard

The new standard, effective in July 2003, will regulate NOx, HC and CO for groups of previously unregulated nonroad engines. The new standard will apply to all new engines sold in the US and imported after these standards begin and large spark-ignition engines (forklifts and airport ground service equipment), recreational vehicles (off-highway motorcycles and all-terrain-vehicles), and recreational marine diesel engines. The regulation varies based upon the type of engine or vehicle.

The large spark-ignition engines contribute to ozone formation and ambient CO and PM levels in urban areas. Tier 1 of this standard is scheduled for implementation in 2004 and Tier 2 is scheduled to start in 2007. Like the large spark-ignition, recreational vehicles contribute to ozone formation and ambient CO and PM levels. They can also be a factor in regional haze and other visibility problems in both state and national parks. For the off-highway motorcycles and all-terrain-vehicles, model year 2006, the new exhaust emissions standard will be phased-in by 50% and for model years 2007 and later a 100%. Recreational marine diesel engines over 37 kW are used in yachts, cruisers, and other types of pleasure craft. Recreational marine engines contribute to ozone formation and PM levels, especially in marinas. Depending on the size of the engine, the standard for will begin phase-in in 2006.

When all of the standards are fully implemented, an overall 72% reduction in HC, 80% reduction in NOx, and 56% reduction in CO emissions are expected by 2020. These controls will help reduce ambient concentrations of ozone, CO, and fine PM.

6. ATTAINMENT DEMONSTRATION

6.1 Status of Current Modeling

Modeling completed to date include: the base case model evaluation/validation runs, the current year modeling runs and the preliminary 2007 future year modeling runs. The results of these modeling runs can be viewed at the NCDAQ modeling website:

http://www.cep.unc.edu/empd/projects2/NCDAQ/PGM/results/

NCDAQ will complete the final 2007 future year modeling run with the updates described in the emissions inventory section. Additionally, the continued maintenance demonstration modeling runs for 2012 and 2017 will be completed in the following months. The results of these modeling runs will be part of the State's submittal in December 2004.

Some errors were found in the base year modeling inventories outside of North Carolina. The magnitude of the errors will be evaluated and, if warranted, the base year model evaluation/validation runs may be re-run.

6.2 Preliminary Modeling Results

The base case model runs for all three episodes met the validation criteria set by the EPA. The model evaluation statistics can be viewed at the NCDAQ modeling website cited above. Figures 6.2-1 and 6.2-2 display the modeling results for 8-hour ozone episodic maximum for the 2000 current year and the 2007 future year, respectively, for the 1996 modeling episode. One can see a significant decrease in the 8-hour ozone episode maximum between the current year and the future year. This is better visualized with Figure 6.2-3, the difference plot between the 2007 future year and the 2000 current year 8-hour ozone episodic maximum for the 1996 episode (i.e., 2007 modeling result minus 2000 modeling results). In this figure cool colors, the blues and greens, represents decreases in the 8-hour ozone episodic maximum. These decreases were the results of the all of the State and Federal control measures listed in Section 5 that are expected to be in place by 2007.

The 1997 episode shows similar results. Figures 6.2-4 through 6.2-5 are the 8-hour ozone episodic maximum for the 2000 current year and the 2007 future year, respectively, for the 1997 episode and Figure 6.2-6 is the difference plot between the 2007 future year and the 2000 current year 8-hour ozone episodic maximum for the 1997 episode.

Although the modeling demonstrating continued maintenance of the 8-hour ozone standard into 2012 and 2017 has not been completed to date, modeling has been completed for future year 2010 for a project outside of the EAC modeling. These results can be used to show continued decrease in expected ozone formation beyond the 2007 attainment year.

Modeling results for the 1996 and 1997 episodes using the 2010 future year inventory does continue to show attainment and further reduction in ozone levels compared to the 2007 modeling. Figure 6.2-7 and 6.2-8 display the modeling results for the 1996 episode using the 2010 emissions inventory, showing the 8-hour ozone episodic maximum and the difference plot between 2010 future year and the 2000 current year 8-hour ozone episodic maximum, respectively. In the 2010 difference plots, cool colors of blue and green represent decreases in the 8-hour ozone episodic maximum. Figures 6.2-9 and 6.2-10 display the 8-hour ozone episodic maximum and difference plot, respectively, for the 1997 episode as modeled for future year 2010 (compared to current year 2000). These results are consistent with the 1996 episode results.

Figure 6.2-1 2000 current year 8-hour ozone episodic maximum for the 1996 episode.

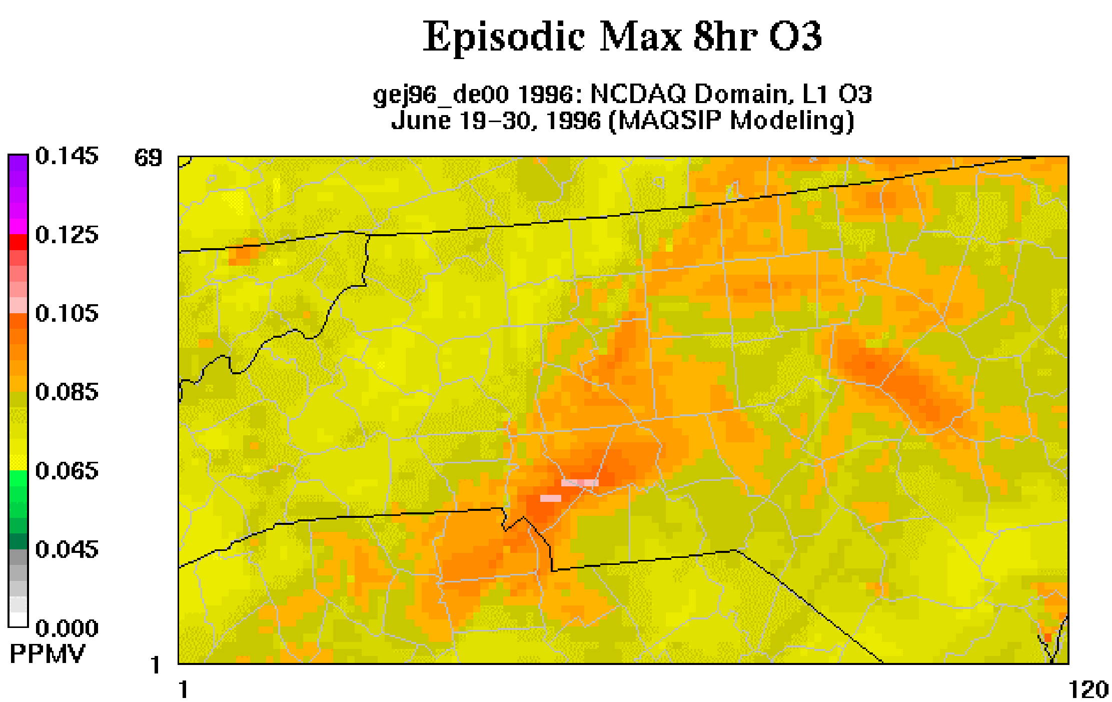


Figure 6.2-2 2007 future year 8-hour ozone episodic maximum for the 1996 episode.

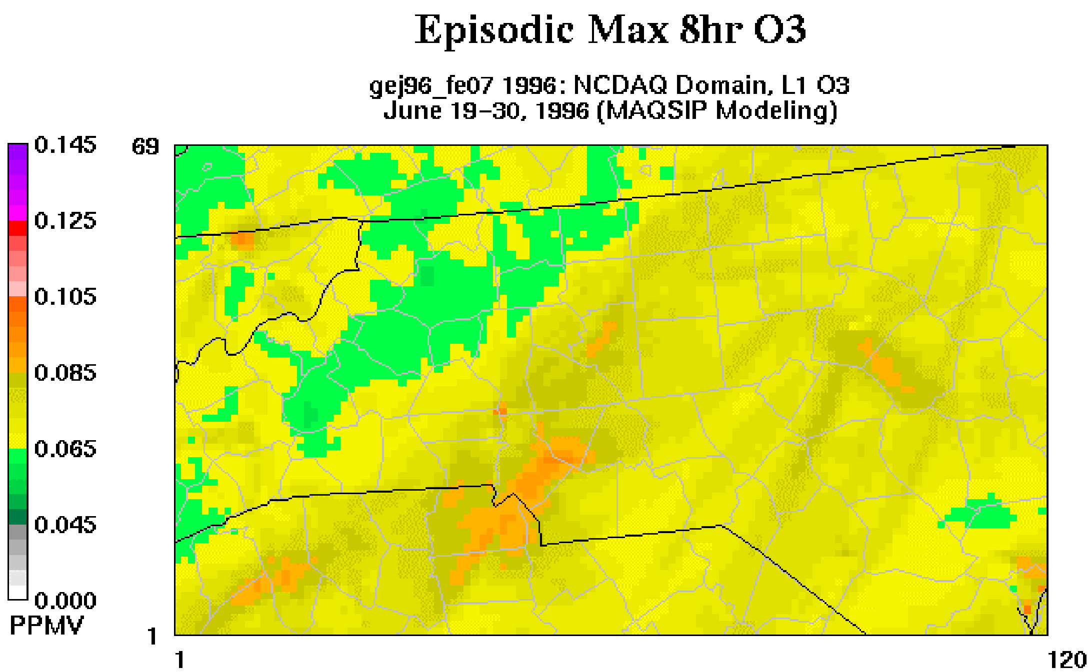


Figure 6.2-3 Difference plot between the 2007 future year and the 2000 current year 8-hour ozone episodic maximum for the 1996 episode.

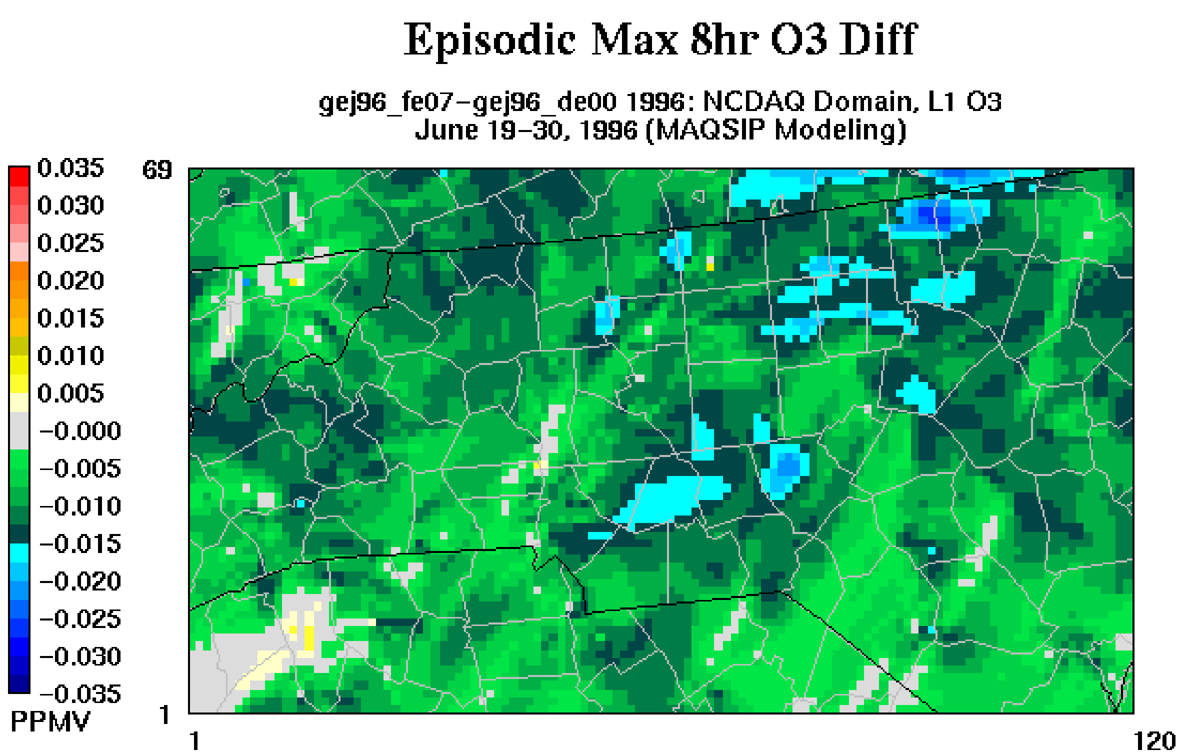


Figure 6.2-4 2000 current year 8-hour ozone episodic maximum for the 1997 episode.

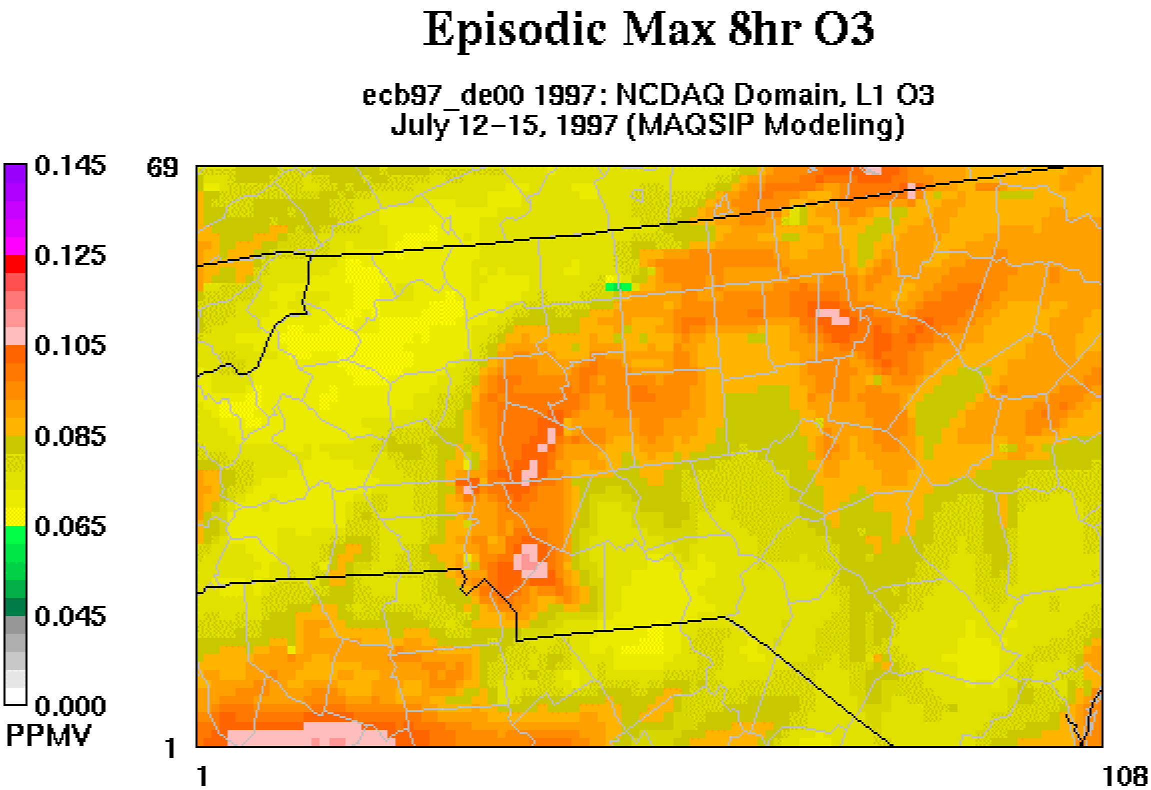


Figure 6.2-5 2007 future year 8-hour ozone episodic maximum for the 1997 episode.

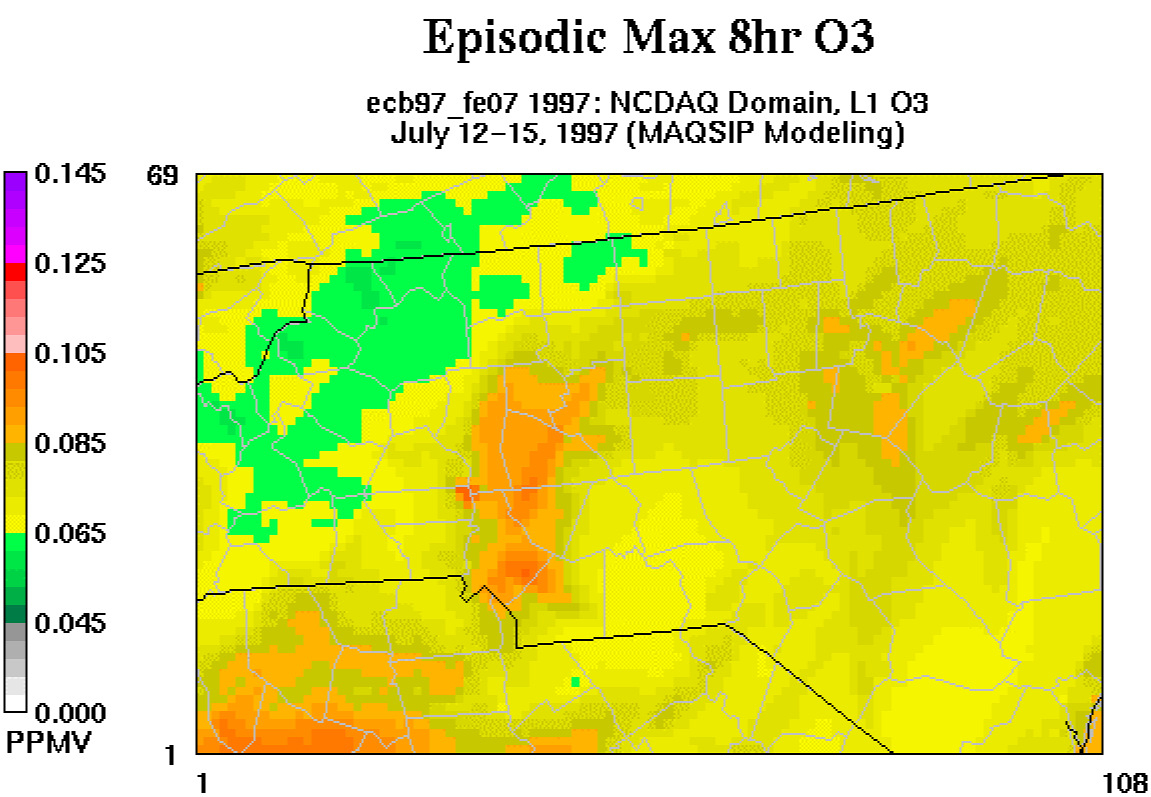


Figure 6.2-6 Difference plot between the 2007 future year and the 2000 current year 8-hour ozone episodic maximum for the 1997 episode.

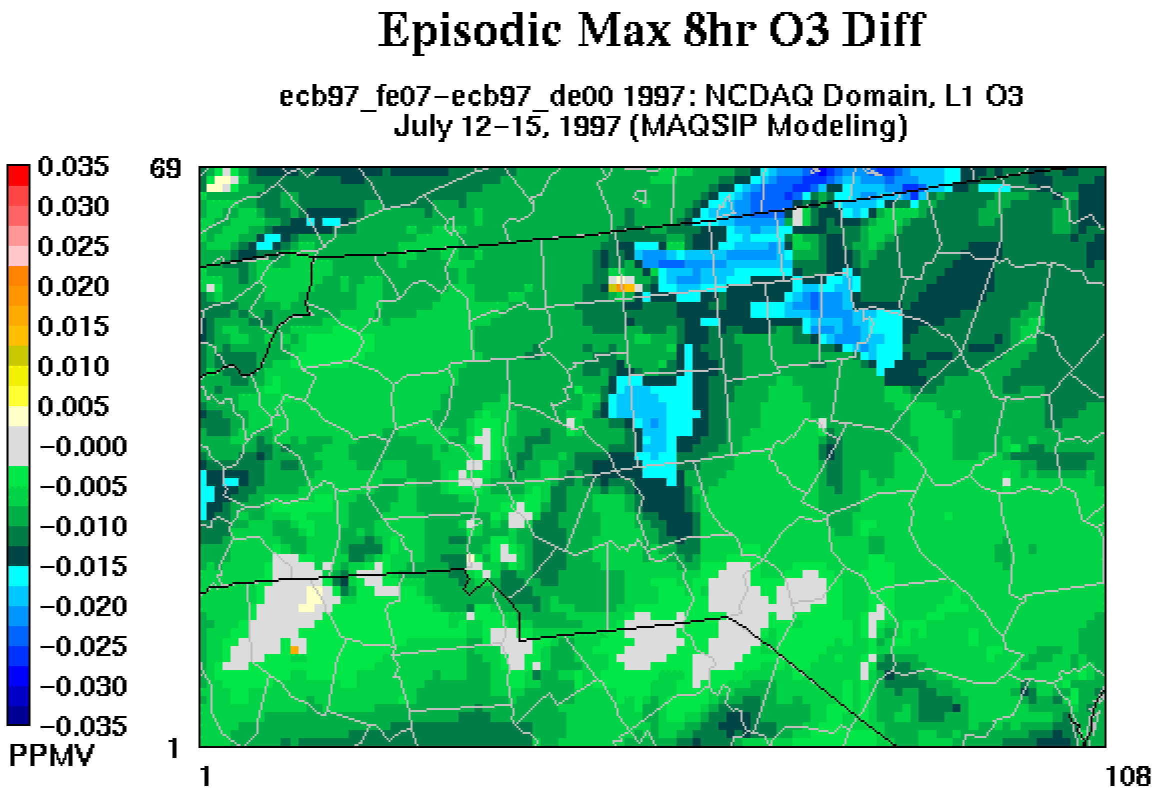


Figure 6.2-7 2010 future year 8-hour ozone episodic maximum for the 1996 episode.

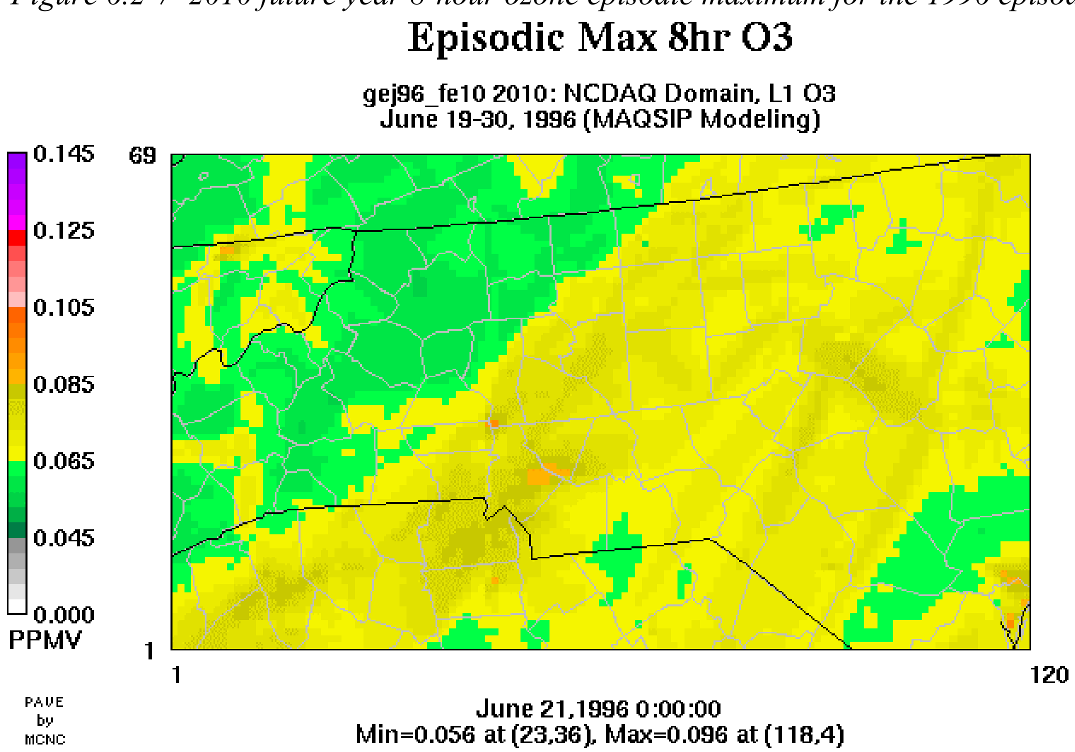


Figure 6.2-8 Difference plot between the 2010 future year and the 2000 current year 8-hour ozone episodic maximum for the 1996 episode.

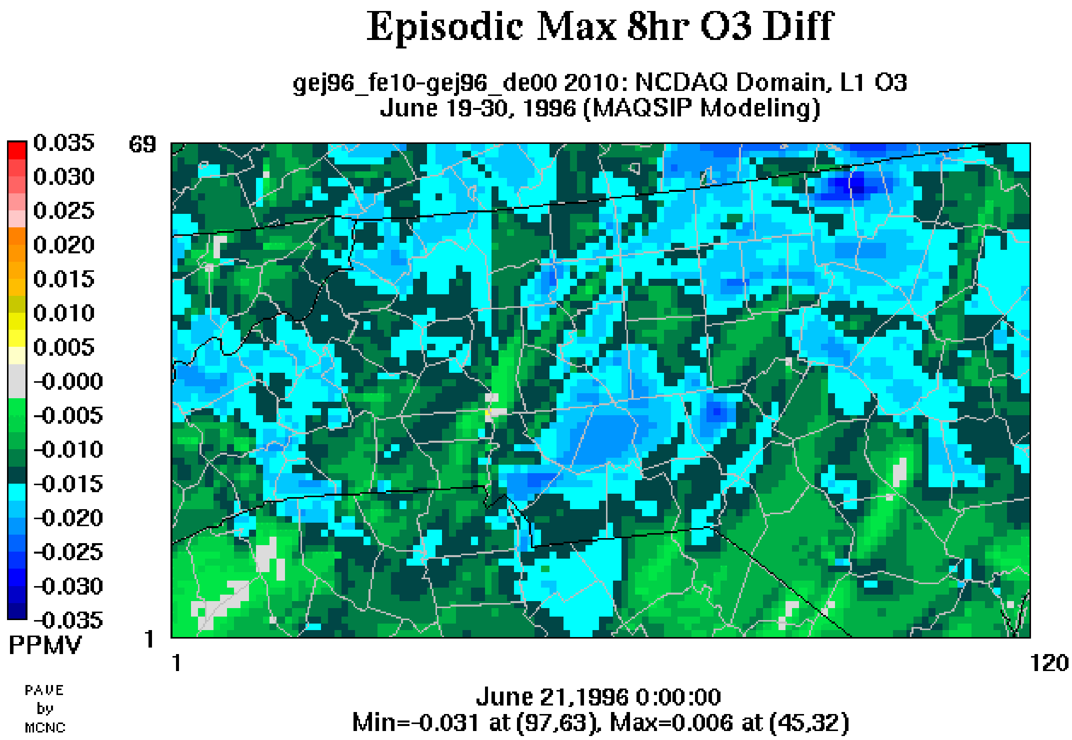


Figure 6.2-9 2010 future year 8-hour ozone episodic maximum for the 1997 episode

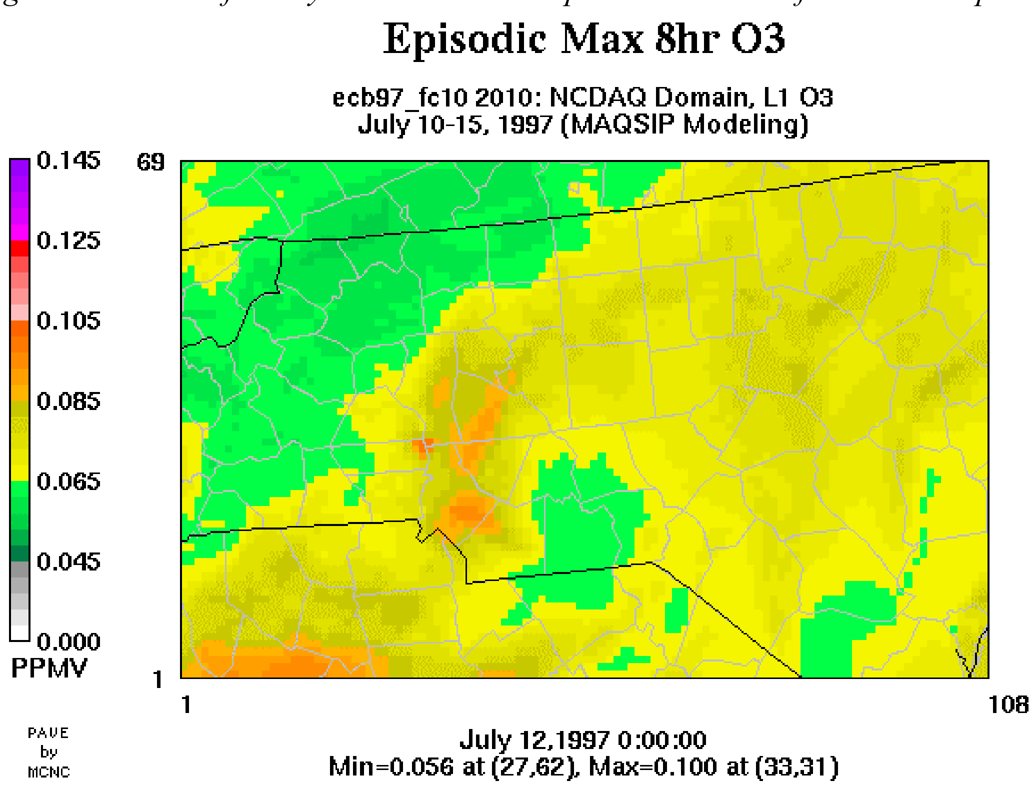
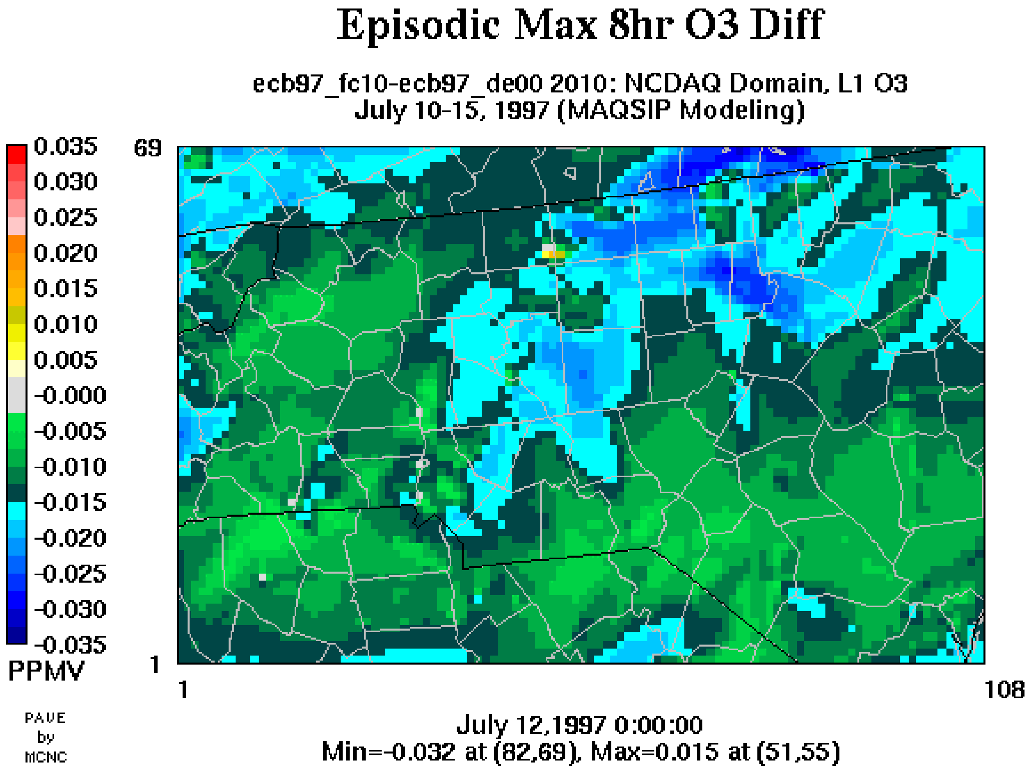


Figure 6.2-10 Difference plot between the 2010 future year and the 2000 current year 8-hour ozone episodic maximum for the 1997 episode



6.3 Geographic Area Needing Further Controls

The current draft version of EPA's attainment test was applied to the modeling results. In very basic and general language the attainment guidance states if the future year design value for a given monitor is below 0.085 parts per million (ppm) then the monitor passes the attainment test. The future year design value of a monitor is calculated by multiplying the current year design value of a monitor by a relative reduction factor (Equation 6.3-1).

Equation 6.3-1

$$DVF = DVC \times RRF$$

Where DVF is the Future year Design Value,
DVC is the Current year Design Value, and
RRF is the relative reduction factor.

The Current year Design Value (DVC) in the attainment test framework is defined as the higher of: (a) the average 4th highest value for the 3-yr period used to designate an area "nonattainment", and (b) the average 4th highest value for the 3-yr period straddling the year represented by the most recent available emissions inventory. In this exercise, the DVC used to designate an area nonattainment will be 2001-2003 and the DVC straddling the year represented

by the most recent available emissions inventory is 1999-2001. The higher of those two values is shown in Table 6.3-1 as the DVC.
The relative reduction factor (RRF) is calculated by taking the ratio of the future year modeling 8-hour ozone daily maximum to the current year modeling 8-hour ozone daily maximum "near" the monitor averaged over all of the episode days (Equations 6.3-2).

$$RRF = \frac{\text{mean future yr. 8-hr daily max "near" monitor "x"}}{\text{mean current yr. 8-hr daily max "near" monitor "x"}} \qquad \text{Equation 6.3-2}$$

The results of applying the attainment test showed both monitors in the Cumberland County EAC area in attainment of the 8-hour ozone NAAQS in 2007. These results are displayed in Table 6.3-1 below.

Table 6.3-1 2007 Attainment Test Results for Cumberland County EAC Area

Monitor	DVC (ppm)	RRF	DVF (ppm)
Wade	0.088	0.91	0.080
Golfview (Hope Mills)	0.087	0.90	0.078

Table 6.3-2 shows the results of applying the attainment test for the EAC monitors in 2010. These preliminary results indicate that the expected State and Federal control measures already in place by 2010 results in all monitors in the Fayetteville EAC area continuing to attain the 8-hour ozone NAAQS. In fact, all of the expected future year design values dropped between the 2007 and 2010 modeling runs, indicating that continued maintenance of the standard in 2012 would be expected.

Table 6.3-2 2010 Attainment Test Results for Cumberland County EAC Area

Monitor	DVC (ppm)	RRF	DVF (ppm)
Wade	0.088	0.85	0.074
Golfview (Hope Mills)	0.087	0.85	0.073

6.4 Anticipated Resource Constraints

The resource constraint of most concern is the funding needed to implement some of the local control measures. NCDAQ and the local EAC areas are both looking for grant opportunities to help fund EAC initiatives.

References:

1. U.S. EPA. National Ambient Air Quality Standards. http://www.epa.gov/airs/criteria.html.

2. McConnell et al. 2002. Asthma in exercising children exposed to ozone: a cohort study. Lancet 359: 386-391.

3. U.S. EPA. "Smog – Who Does It Hurt? What You Need to Know about Ozone and Your Health" http://www.epa.gov/airnow/health/index.html.

APPENDIX A

Stationary Point Sources Emissions in tons/day

County	2000			2007		
	CO	NOx	VOC	CO	NOx	VOC
Alamance	0.68	0.66	1.60	0.07	0.76	1.03
Alexander	0.03	0.04	1.38	0.02	0.00	1.66
Alleghany	0.00	0.01	0.03			
Anson	0.13	0.46	0.38	0.00	0.00	0.00
Ashe	0.23	0.16	0.34	0.03	0.01	1.23
Avery	0.00	0.01	0.00			
Beaufort	0.04	0.20	0.30	1.48	2.48	0.34
Bertie	0.69	0.36	0.57	0.18	0.27	1.04
Bladen	0.40	1.19	0.49	0.23	2.33	0.58
Brunswick	14.55	6.64	3.87	4.78	9.81	2.79
Buncombe	1.25	53.32	3.60	13.78	13.79	3.10
Burke	2.55	0.84	5.18	7.87	0.61	13.73
Cabarrus	0.82	3.03	4.06	0.18	2.10	3.60
Caldwell	1.35	1.19	21.88	0.51	0.16	28.09
Camden	0.00	0.00	0.00			
Carteret	0.15	0.22	0.30	0.01	0.11	0.00
Caswell						
Catawba	4.16	96.23	18.81	13.14	51.84	20.46
Chatham	4.51	21.19	2.21	7.90	4.72	2.16
Cherokee	0.02	0.02	0.22			
Chowan	0.03	0.21	0.37	0.03	0.15	0.01
Clay						
Cleveland	0.82	1.70	1.04	0.80	4.46	1.62
Columbus	20.82	15.41	6.93	15.75	9.05	2.53
Craven	4.94	4.21	3.73	4.54	4.94	1.85
Cumberland	1.22	3.16	4.08	0.51	3.76	6.86
Currituck	0.08	0.01	0.00			
Dare	0.05	0.19	0.01	0.01	0.34	0.00
Davidson	3.31	12.16	15.05	3.02	6.34	20.47
Davie	0.17	0.20	1.98	0.09	0.04	3.79
Duplin	0.24	1.10	0.14	1.11	2.41	0.02
Durham	1.00	1.58	1.19	0.30	1.03	5.73
Edgecombe	0.49	5.95	0.90	0.43	7.29	0.02
Forsyth	2.09	6.15	9.76	1.96	6.78	19.96
Franklin	0.28	0.21	1.71	0.01	0.13	0.12
Gaston	3.67	86.48	5.40	21.44	38.21	7.51
Gates	0.08	0.03	0.10			

Stationary Point Sources Emissions in tons/day

County	2000			2007		
	CO	NOx	VOC	CO	NOx	VOC
Graham	0.09	0.08	1.29	0.02	0.02	1.38
Granville	0.34	0.36	1.79	0.37	0.13	1.92
Greene	0.00	0.07	0.00			
Guilford	1.59	1.83	18.13	0.17	0.88	39.44
Halifax	6.22	10.72	1.71	17.11	12.80	0.41
Harnett	0.20	0.33	1.12	0.23	0.63	0.62
Haywood	7.85	12.48	5.00	9.26	16.05	2.44
Henderson	0.25	0.31	3.79	0.03	0.43	4.53
Hertford	1.33	0.47	1.13	0.02	0.17	0.24
Hoke	0.08	0.25	0.40	34.24	1.00	10.35
Hyde	0.00	0.04	0.00			
Iredell	3.58	9.98	20.42	3.63	11.15	4.37
Jackson	0.60	0.52	0.38	0.00	0.05	0.00
Johnston	0.80	0.46	1.80	0.02	0.15	2.46
Jones						
Lee	1.37	0.42	1.27	1.14	0.28	0.75
Lenoir	0.63	2.27	1.30	0.14	3.10	0.23
Lincoln	0.76	5.82	2.73	8.90	14.26	2.18
McDowell	2.12	1.04	3.87	0.78	0.71	1.33
Macon	0.11	0.08	0.05			
Madison	0.02	0.07	0.00			
Martin	10.72	10.38	3.24	31.74	9.97	3.18
Mecklenburg	5.49	2.30	11.99	3.32	3.73	23.26
Mitchell	0.41	0.50	2.49	0.13	0.02	2.09
Montgomery	0.24	0.32	1.99	0.05	0.01	0.02
Moore	0.17	0.14	2.29	0.02	0.00	1.74
Nash	9.02	0.97	2.67	0.50	1.06	0.56
NewHanover	35.65	31.96	6.52	46.31	49.30	6.49
Northampton	1.10	0.30	0.86	0.14	0.30	0.10
Onslow	0.34	1.77	0.16	0.09	1.22	0.02
Orange	2.86	1.80	0.37	3.37	0.78	0.01
Pamlico						
Pasquotank	0.10	0.07	0.07	0.01	0.02	0.03
Pender	0.00	0.00	0.05	0.02	0.03	0.01
Perquimans						
Person	5.79	205.34	1.36	13.83	32.70	1.22
Pitt	1.06	0.88	1.95	0.37	0.75	1.11
Polk	0.02	0.03	0.00			
Randolph	0.53	0.38	4.01	0.02	0.07	2.33
Richmond	0.33	0.26	0.17	323.38	11.45	10.71
Robeson	0.92	17.43	1.12	1.64	13.56	2.28
Rockingham	5.60	34.09	16.65	17.02	16.47	8.01
Rowan	2.28	37.52	8.27	15.19	19.17	11.65

Stationary Point Sources Emissions in tons/day

County	2000			2007		
	CO	NOx	VOC	CO	NOx	VOC
Rutherford	3.24	49.60	2.56	4.66	13.67	3.45
Sampson	0.24	0.23	0.22			
Scotland	0.38	6.14	3.60	0.57	8.50	7.33
Stanly	26.81	1.15	1.79	17.59	1.36	1.94
Stokes	8.15	324.10	1.01	5.16	22.79	0.62
Surry	3.28	1.09	6.10	6.10	1.06	4.12
Swain	0.00	0.00	0.12			
Transylvania	0.21	5.00	2.83	0.25	7.01	2.55
Tyrrell						
Union	0.81	0.68	1.81	0.03	0.17	2.54
Vance	0.34	1.52	1.16	0.04	1.45	0.00
Wake	1.59	1.49	4.24	0.27	0.94	10.08
Warren	0.18	0.08	0.07			
Washington	0.00	0.00	0.00	0.00	0.01	0.00
Watauga	0.17	0.18	0.13	0.02	0.05	0.00
Wayne	5.08	19.84	3.38	24.50	27.43	1.85
Wilkes	1.88	0.97	5.69	3.68	0.83	6.11
Wilson	0.51	1.48	3.74	0.22	2.51	1.99
Yadkin	0.01	0.03	0.26	0.00	0.00	0.03
Yancey						

Stationary Area Sources Emissions in tons/day

County	2000			2007		
	CO	NOx	VOC	CO	NOx	VOC
Alamance	6.21	0.47	5.78	6.65	0.50	6.17
Alexander	3.26	0.20	2.96	3.42	0.21	2.93
Alleghany	1.00	0.08	0.79	1.03	0.08	0.81
Anson	3.83	0.16	1.40	4.14	0.17	1.47
Ashe	2.29	0.17	1.42	2.36	0.17	1.50
Avery	1.61	0.12	0.85	1.66	0.13	0.90
Beaufort	22.68	0.30	5.75	25.28	0.31	5.93
Bertie	6.46	0.16	3.25	7.09	0.17	3.20
Bladen	5.37	0.25	3.08	5.79	0.25	3.13
Brunswick	5.25	0.39	3.12	5.47	0.40	3.26
Buncombe	5.74	0.55	8.11	5.91	0.58	8.66
Burke	4.02	0.32	3.48	4.15	0.33	3.64
Cabarrus	5.81	0.38	5.88	6.26	0.41	6.52
Caldwell	3.19	0.25	3.91	3.32	0.25	4.05
Camden	7.54	0.05	1.35	8.43	0.05	1.40
Carteret	5.22	0.20	2.96	5.67	0.20	3.10
Caswell	3.96	0.18	1.69	4.24	0.19	1.71
Catawba	7.04	0.43	11.22	7.48	0.44	11.37

Stationary Area Sources Emissions in tons/day

County	2000			2007		
	CO	NOx	VOC	CO	NOx	VOC
Chatham	4.82	0.34	2.46	5.18	0.36	2.58
Cherokee	2.29	0.19	1.15	2.35	0.20	1.19
Chowan	2.70	0.09	1.61	2.96	0.09	1.65
Clay	0.83	0.08	0.46	0.85	0.08	0.51
Cleveland	8.89	0.43	4.45	9.53	0.45	4.70
Columbus	10.62	0.41	5.37	11.52	0.42	5.36
Craven	6.34	0.28	4.92	6.87	0.29	5.06
Cumberland	6.32	0.51	11.54	6.76	0.54	12.12
Currituck	8.37	0.14	1.61	9.27	0.14	1.71
Dare	0.86	0.08	1.21	0.89	0.08	1.30
Davidson	9.36	0.65	7.74	9.81	0.67	7.96
Davie	4.37	0.19	1.76	4.69	0.20	1.87
Duplin	17.79	0.37	5.91	19.65	0.38	5.95
Durham	2.25	0.35	7.67	2.42	0.39	8.18
Edgecombe	4.60	0.25	5.60	4.96	0.26	5.50
Forsyth	3.94	0.40	11.46	4.18	0.44	12.21
Franklin	7.51	0.36	3.18	8.19	0.37	3.25
Gaston	5.05	0.52	6.85	5.35	0.56	7.35
Gates	1.82	0.08	1.14	1.95	0.09	1.12
Graham	0.75	0.06	0.35	0.77	0.06	0.37
Granville	7.05	0.27	3.27	7.65	0.28	3.34
Greene	5.83	0.15	2.95	6.40	0.16	2.88
Guilford	10.99	0.95	19.33	11.77	1.04	20.36
Halifax	9.79	0.30	5.16	10.73	0.31	5.19
Harnett	8.91	0.51	5.74	9.49	0.52	5.80
Haywood	2.44	0.21	2.08	2.51	0.21	2.18
Henderson	4.02	0.37	3.51	4.14	0.38	3.72
Hertford	5.54	0.13	2.34	6.11	0.13	2.38
Hoke	3.54	0.16	1.85	3.82	0.16	1.88
Hyde	4.91	0.05	1.45	5.48	0.05	1.45
Iredell	9.47	0.51	6.14	10.19	0.54	6.46
Jackson	2.45	0.21	1.23	2.52	0.21	1.30
Johnston	12.71	0.73	9.46	13.78	0.76	9.42
Jones	4.70	0.08	1.81	5.20	0.09	1.78
Lee	4.54	0.21	2.57	4.90	0.22	2.68
Lenoir	8.28	0.26	5.44	9.09	0.27	5.45
Lincoln	6.50	0.30	2.82	7.01	0.31	3.04
McDowell	2.28	0.20	1.30	2.35	0.21	1.37
Macon	1.85	0.14	0.98	1.90	0.14	1.02
Madison	1.87	0.18	1.41	1.93	0.18	1.42
Martin	5.52	0.23	3.59	5.93	0.24	3.54
Mecklenburg	4.61	0.99	25.87	4.97	1.12	28.14
Mitchell	1.47	0.11	0.91	1.52	0.11	0.93

Stationary Area Sources Emissions in tons/day

County	2000			2007		
	CO	NOx	VOC	CO	NOx	VOC
Montgomery	2.44	0.18	1.81	2.53	0.19	1.83
Moore	4.97	0.35	3.49	5.20	0.37	3.66
Nash	9.24	0.42	7.76	10.02	0.44	7.75
NewHanover	0.77	0.12	6.04	0.79	0.13	6.51
Northampton	5.09	0.16	2.65	5.55	0.17	2.60
Onslow	6.21	0.34	5.99	6.59	0.35	6.29
Orange	5.03	0.40	4.54	5.42	0.43	4.79
Pamlico	6.27	0.10	1.38	6.95	0.11	1.44
Pasquotank	12.97	0.14	3.18	14.47	0.14	3.37
Pender	5.90	0.28	2.47	6.30	0.29	2.61
Perquimans	6.91	0.09	1.76	7.68	0.09	1.79
Person	6.29	0.23	2.42	6.85	0.24	2.49
Pitt	9.95	0.46	9.13	10.78	0.47	9.36
Polk	1.57	0.13	0.70	1.61	0.13	0.74
Randolph	10.44	0.66	9.38	11.07	0.68	9.47
Richmond	2.58	0.20	2.01	2.71	0.21	2.11
Robeson	28.32	0.70	9.95	31.17	0.72	10.19
Rockingham	8.86	0.46	4.47	9.48	0.48	4.64
Rowan	9.50	0.46	5.66	10.28	0.49	6.08
Rutherford	4.44	0.31	2.68	4.64	0.33	2.96
Sampson	17.24	0.43	7.57	18.96	0.44	7.53
Scotland	7.55	0.17	2.36	8.33	0.17	2.47
Stanly	8.31	0.32	3.28	9.01	0.33	3.42
Stokes	4.56	0.26	2.42	4.82	0.27	2.45
Surry	6.15	0.37	4.01	6.47	0.38	4.16
Swain	1.22	0.10	0.50	1.26	0.10	0.52
Transylvania	1.75	0.16	1.08	1.80	0.17	1.14
Tyrrell	10.04	0.03	1.72	11.27	0.04	1.79
Union	23.79	0.55	7.20	26.31	0.58	7.68
Vance	4.19	0.19	2.43	4.52	0.19	2.51
Wake	10.49	1.24	24.71	11.31	1.35	26.08
Warren	4.18	0.16	1.44	4.52	0.16	1.47
Washington	12.80	0.08	2.51	14.34	0.09	2.60
Watauga	2.41	0.20	1.82	2.48	0.20	1.91
Wayne	16.32	0.48	7.91	17.91	0.49	8.07
Wilkes	4.79	0.37	3.35	4.95	0.38	3.49
Wilson	5.47	0.29	6.51	5.92	0.30	6.46
Yadkin	6.30	0.23	2.77	6.82	0.23	2.85
Yancey	1.67	0.12	0.90	1.72	0.13	0.92

Nonroad Mobile Sources Emissions in tons/day

County	2000			2007		
	CO	NOx	VOC	CO	NOx	VOC
Alamance	29.54	2.98	2.37	33.64	2.91	2.04
Alexander	4.00	0.51	0.37	4.36	0.53	0.33
Alleghany	2.49	0.36	0.18	2.78	0.33	0.14
Anson	4.19	1.13	0.50	4.55	0.95	0.39
Ashe	3.91	0.44	0.41	4.54	0.43	0.44
Avery	5.37	0.52	0.59	6.39	0.47	0.65
Beaufort	13.85	2.81	2.74	15.07	2.51	2.30
Bertie	6.43	1.66	1.12	6.78	1.48	0.88
Bladen	8.96	1.81	1.44	10.50	1.59	1.66
Brunswick	27.00	2.10	4.70	30.90	1.88	4.16
Buncombe	48.93	4.51	4.43	57.45	4.28	4.27
Burke	14.79	2.10	1.51	16.50	2.05	1.51
Cabarrus	44.68	4.19	3.28	51.35	3.78	2.38
Caldwell	16.55	2.38	1.77	18.65	2.34	1.89
Camden	2.84	0.41	0.99	2.90	0.39	0.80
Carteret	49.17	1.82	14.18	54.95	1.90	12.43
Caswell	2.26	1.07	0.23	2.51	0.85	0.17
Catawba	47.03	5.15	4.20	53.29	5.17	3.95
Chatham	12.91	1.83	1.40	14.40	1.68	1.09
Cherokee	3.99	0.40	0.56	4.58	0.40	0.57
Chowan	4.05	0.47	1.14	4.45	0.46	1.03
Clay	2.19	0.15	0.43	2.72	0.14	0.54
Cleveland	21.51	2.13	1.75	24.58	2.08	1.52
Columbus	9.85	2.12	1.11	11.13	1.89	1.00
Craven	24.08	2.20	2.66	27.45	1.94	1.98
Cumberland	59.31	6.51	4.85	68.38	5.86	3.84
Currituck	15.63	0.77	4.69	17.55	0.77	4.24
Dare	46.18	1.33	18.14	49.76	1.54	15.68
Davidson	30.96	4.24	2.64	35.03	3.90	2.24
Davie	6.77	0.61	0.88	8.20	0.61	1.12
Duplin	10.19	2.36	0.97	11.18	2.13	0.73
Durham	70.50	9.63	6.04	79.17	9.06	5.09
Edgecombe	11.11	2.57	0.97	12.27	2.28	0.78
Forsyth	91.57	6.94	6.70	105.60	6.76	5.27
Franklin	8.37	1.05	0.78	9.71	0.93	0.70
Gaston	54.10	4.77	3.98	61.82	4.70	3.33
Gates	1.58	0.50	0.21	1.69	0.45	0.16
Graham	1.40	0.13	0.25	1.55	0.12	0.20
Granville	13.73	1.39	1.23	15.64	1.32	1.03
Greene	2.31	0.70	0.21	2.52	0.64	0.16
Guilford	194.02	14.69	14.06	226.39	13.97	10.89
Halifax	8.68	2.13	0.92	9.77	1.86	0.83

Nonroad Mobile Sources Emissions in tons/day

County	2000			2007		
	CO	NOx	VOC	CO	NOx	VOC
Harnett	22.07	1.84	1.65	25.33	1.72	1.21
Haywood	11.35	1.08	1.15	13.38	1.00	1.19
Henderson	31.53	2.07	3.82	38.22	1.95	4.41
Hertford	4.08	0.54	0.48	4.74	0.50	0.48
Hoke	3.35	0.64	0.28	3.61	0.62	0.24
Hyde	25.38	1.93	11.68	25.59	1.94	9.56
Iredell	21.67	2.88	2.10	24.69	2.78	1.97
Jackson	6.55	0.51	0.75	7.75	0.46	0.76
Johnston	35.04	3.41	2.84	40.55	3.09	2.26
Jones	1.83	0.46	0.15	2.05	0.41	0.12
Lee	16.81	2.46	1.35	18.80	2.29	1.07
Lenoir	16.43	2.14	1.31	18.63	2.00	1.01
Lincoln	14.00	1.49	1.27	16.03	1.38	1.10
McDowell	7.93	1.84	1.14	9.18	1.61	1.36
Macon	10.89	0.53	0.97	12.89	0.50	0.91
Madison	1.73	0.56	0.17	1.96	0.45	0.13
Martin	4.71	1.32	0.51	5.37	1.16	0.51
Mecklenburg	351.64	23.31	24.93	298.78	21.99	18.42
Mitchell	3.61	1.02	0.51	4.27	0.85	0.61
Montgomery	4.89	0.71	0.58	5.34	0.66	0.48
Moore	27.52	1.89	1.95	31.86	1.73	1.41
Nash	21.77	2.69	1.71	24.83	2.47	1.32
NewHanover	58.02	4.59	5.80	67.25	4.20	4.55
Northampton	4.56	0.97	0.71	5.20	0.86	0.65
Onslow	26.34	3.52	3.92	29.60	3.21	3.31
Orange	31.55	3.66	3.18	37.13	3.19	3.09
Pamlico	9.11	0.88	3.58	9.63	0.85	3.09
Pasquotank	9.56	0.93	1.42	10.86	0.88	1.12
Pender	13.17	1.02	1.77	15.00	0.95	1.44
Perquimans	3.95	0.65	1.27	4.10	0.60	1.02
Person	8.34	0.85	0.80	9.41	0.82	0.64
Pitt	25.16	4.26	1.98	28.79	3.78	1.53
Polk	2.69	0.46	0.22	3.03	0.39	0.17
Randolph	27.23	2.82	2.20	30.77	2.85	1.94
Richmond	14.38	4.66	1.43	15.38	4.02	1.05
Robeson	19.63	5.97	1.91	21.45	5.21	1.62
Rockingham	15.35	2.44	1.55	17.39	2.26	1.63
Rowan	28.37	5.47	2.59	31.85	4.75	2.11
Rutherford	13.10	2.19	1.27	14.86	2.00	1.27
Sampson	10.67	2.15	0.92	11.89	1.96	0.70
Scotland	8.59	1.82	0.75	9.46	1.64	0.63
Stanly	16.77	2.09	1.54	19.02	1.96	1.29
Stokes	8.18	0.68	0.72	9.54	0.61	0.64

Nonroad Mobile Sources Emissions in tons/day

County	2000			2007		
	CO	NOx	VOC	CO	NOx	VOC
Surry	30.76	1.96	2.43	35.44	1.98	2.05
Swain	4.84	0.35	1.35	6.47	0.32	1.88
Transylvania	15.89	0.68	2.79	20.28	0.67	3.77
Tyrrell	6.72	0.61	2.94	6.76	0.61	2.38
Union	47.65	3.89	3.56	55.34	3.56	2.71
Vance	6.24	1.24	0.75	6.84	1.14	0.62
Wake	242.05	18.83	17.61	281.90	17.33	12.59
Warren	3.51	0.70	0.58	3.85	0.56	0.43
Washington	5.43	1.03	1.44	5.68	0.95	1.16
Watauga	9.79	0.50	1.19	12.02	0.48	1.41
Wayne	26.05	3.51	2.10	29.98	3.27	1.71
Wilkes	16.62	1.37	1.38	19.09	1.32	1.17
Wilson	23.57	2.99	1.95	27.15	2.67	1.56
Yadkin	6.59	0.89	0.52	7.45	0.83	0.40
Yancey	7.75	0.37	0.87	9.32	0.34	0.94

Highway Mobile Sources Emissions in tons/day

County	2000			2007		
	CO	NOx	VOC	CO	NOx	VOC
Alamance	93.84	13.48	8.34	54.81	9.52	5.01
Alexander	15.87	1.75	1.41	10.67	1.27	1.02
Alleghany	6.87	0.74	0.61	3.84	0.45	0.37
Anson	22.65	2.93	1.90	14.23	2.00	1.25
Ashe	15.28	1.61	1.36	8.98	1.03	0.86
Avery	13.78	1.66	1.18	7.98	1.05	0.73
Beaufort	31.89	3.55	2.81	19.36	2.35	1.81
Bertie	19.81	2.38	1.70	12.41	1.61	1.14
Bladen	29.89	3.22	2.65	18.60	2.18	1.78
Brunswick	67.90	8.19	5.82	39.68	5.53	3.69
Buncombe	149.98	23.51	13.10	87.96	16.25	7.83
Burke	65.51	12.34	5.64	36.98	7.79	3.38
Cabarrus	69.09	12.04	6.19	50.62	8.59	4.20
Caldwell	44.10	5.01	3.89	25.98	3.41	2.48
Camden	7.47	0.90	0.64	4.68	0.61	0.43
Carteret	43.77	5.41	3.74	22.53	3.19	2.10
Caswell	16.69	2.00	1.44	10.41	1.34	0.95
Catawba	113.03	15.57	10.08	66.68	10.71	6.25
Chatham	45.51	5.79	3.85	27.65	4.01	2.55
Cherokee	17.05	2.25	1.42	12.85	1.73	1.15
Chowan	8.16	0.92	0.72	4.87	0.60	0.45
Clay	6.05	0.68	0.53	3.81	0.46	0.36
Cleveland	68.95	10.19	5.97	37.44	6.17	3.49

Highway Mobile Sources Emissions in tons/day

County	2000			2007		
	CO	NOx	VOC	CO	NOx	VOC
Columbus	43.72	5.12	3.80	27.16	3.52	2.47
Craven	57.77	6.75	5.06	34.07	4.53	3.19
Cumberland	197.16	28.43	17.85	108.27	18.56	10.31
Currituck	21.48	2.50	1.86	14.09	1.77	1.33
Dare	37.56	4.27	3.27	20.22	2.55	1.89
Davidson	105.57	17.25	9.73	61.60	11.04	6.06
Davie	32.17	7.98	2.67	20.32	5.05	1.78
Duplin	46.97	8.80	4.00	32.00	6.34	2.86
Durham	130.59	24.00	11.93	90.71	14.51	7.74
Edgecombe	41.11	4.72	3.61	23.96	3.17	2.28
Forsyth	188.14	33.73	18.97	125.17	19.34	12.44
Franklin	32.41	3.79	2.81	19.70	2.63	1.89
Gaston	87.61	16.61	8.66	56.34	9.20	5.28
Gates	8.85	1.12	0.75	5.30	0.73	0.47
Graham	4.84	0.50	0.43	3.31	0.39	0.32
Granville	48.49	9.82	5.02	27.96	5.43	3.29
Greene	14.77	1.63	1.30	9.41	1.14	0.89
Guilford	274.08	47.66	27.88	179.81	26.94	18.09
Halifax	48.63	11.44	4.09	31.41	7.19	2.75
Harnett	58.38	9.34	5.01	34.75	6.19	3.25
Haywood	58.30	14.16	4.81	33.85	8.92	2.99
Henderson	59.39	10.05	5.15	34.27	6.56	3.17
Hertford	15.08	1.71	1.32	9.26	1.14	0.87
Hoke	18.56	2.22	1.60	12.36	1.62	1.13
Hyde	4.39	0.48	0.39	2.61	0.32	0.25
Iredell	119.96	29.26	10.08	71.75	18.66	6.42
Jackson	36.42	4.77	3.04	23.49	3.29	2.08
Johnston	123.04	28.31	10.21	81.29	19.92	7.25
Jones	14.67	1.89	1.23	8.62	1.19	0.76
Lee	39.67	4.49	3.51	23.25	3.03	2.21
Lenoir	44.38	4.70	4.04	23.50	2.85	2.31
Lincoln	37.27	4.27	3.28	21.48	2.82	2.08
McDowell	42.05	9.85	3.48	26.32	3.48	2.37
Macon	24.61	3.09	2.08	15.13	2.02	1.37
Madison	13.33	1.64	1.14	8.25	1.10	0.75
Martin	25.08	3.06	2.15	15.47	3.65	1.34
Mecklenburg	341.23	67.76	34.75	222.60	36.34	21.26
Mitchell	9.55	1.09	0.83	5.95	0.75	0.55
Montgomery	26.55	3.60	2.27	18.18	2.61	1.66
Moore	53.39	5.90	4.73	29.76	3.77	2.87
Nash	93.59	17.62	7.97	53.90	10.92	4.94
NewHanover	81.67	9.12	7.49	48.41	6.14	4.72
Northampton	23.32	4.79	1.95	13.92	2.79	1.24

Highway Mobile Sources Emissions in tons/day

County	2000			2007		
	CO	NOx	VOC	CO	NOx	VOC
Onslow	67.91	7.55	6.03	35.66	4.56	3.41
Orange	62.40	18.80	5.30	44.95	11.91	3.63
Pamlico	9.21	0.93	0.83	5.79	0.64	0.56
Pasquotank	17.53	1.94	1.57	11.15	1.36	1.03
Pender	40.59	8.15	3.41	28.50	5.88	2.53
Perquimans	9.69	1.24	0.82	6.19	0.86	0.54
Person	21.02	2.25	1.89	12.96	1.51	1.23
Pitt	78.82	8.47	7.05	43.54	5.36	4.24
Polk	19.00	4.60	1.56	13.94	3.39	1.19
Randolph	97.79	13.69	8.46	57.60	9.14	5.31
Richmond	40.70	4.98	3.52	24.96	3.35	2.22
Robeson	107.26	20.38	9.20	61.34	12.86	5.62
Rockingham	66.14	7.51	5.82	37.21	4.86	3.57
Rowan	89.79	17.34	7.75	53.43	11.46	4.96
Rutherford	40.07	4.52	3.53	20.79	2.69	2.01
Sampson	51.06	8.35	4.42	32.73	5.69	2.97
Scotland	29.90	3.44	2.64	18.93	2.37	1.73
Stanly	37.66	4.01	3.39	20.69	2.53	2.03
Stokes	24.78	2.82	2.17	13.71	1.79	1.32
Surry	64.94	12.67	5.54	37.68	7.79	3.49
Swain	13.82	1.69	1.18	7.71	1.01	0.70
Transylvania	22.41	2.47	1.99	14.04	1.68	1.33
Tyrrell	3.78	0.49	0.32	2.31	0.33	0.20
Union	56.79	7.70	5.15	39.75	5.00	3.48
Vance	33.57	6.29	2.89	22.07	4.29	1.95
Wake	306.82	59.29	27.61	224.96	39.69	18.67
Warren	15.84	3.56	1.32	10.53	2.39	0.92
Washington	11.19	1.43	0.94	6.82	0.95	0.60
Watauga	25.14	3.08	2.17	15.08	2.02	1.34
Wayne	68.83	7.28	6.20	39.66	4.84	3.87
Wilkes	47.93	5.55	4.18	25.57	3.39	2.45
Wilson	61.49	10.12	5.37	35.49	6.44	3.32
Yadkin	34.98	7.13	2.92	21.93	4.42	1.92
Yancey	11.33	1.45	0.96	6.74	0.93	0.60

APPENDIX B – EARLY ACTION COMPACT

Application of the Early Action Compact for 8-hour State Implementation Plan Development in the Fayetteville Metropolitan Statistical Area North Carolina

Planning Today for Clean Air Tomorrow

An Agreement of Partnership by USEPA Region 4, North Carolina Department of Environment and Natural Resources, and the Cumberland County Board of Commissioners

December 2002

I. Purpose of the Early Action Compact

The Early Action Compact (EAC) is an agreement between the North Carolina Department of Environment and Natural Resources (DENR), local governments and organizations, and the United States Environmental Protection Agency Region 4 (EPA) office. This EAC represents a partnership of Local, State, and Federal agency efforts to develop a State implementation plan (SIP) for the Fayetteville Metropolitan Statistical Area. The SIP is the technical analysis showing what control measures are necessary to attain the 8-hour ozone standard, as well as the adopted rules for those measures. The SIP will be a combination of Local, State, and Federal rules. This EAC includes the memorandum of agreement by all parties, the protocol for the local Early Action Plan (EAP) and the overall SIP development and the schedule the plan development will follow. The result of this EAC is that the SIP will be developed early, the control measures implemented sooner, and the 8-hour ozone standard achieved in a more expeditious manner than following the normal SIP development timeline. Under the EAC schedule, the SIP is due no later than December 31, 2004. Under the normal schedule, the SIP is due three years after the nonattainment designation (expected in 2004, so the SIP would be due in 2007). The ultimate result of the EAC approach is that North Carolinians will breathe clean air sooner. If any party to the EAC fails to achieve a milestone, then the nonattainment designation becomes effective upon EPA finding that failure, and all consequences of nonattainment designation apply to the area. The EAC contains necessary and appropriate mechanisms to return the area to the regular nonattainment planning process should any party fail to meet the agreed upon milestones contained in the EAC.

II. Background and History of Air Quality

Ozone, or O3, is formed in the atmosphere when two primary pollutants, volatile organic compounds and oxides of nitrogen react in the presence of sunlight. DENR operates the ozone monitors from April 1 through October 31 of each year, though most exceedances, or days above the ozone standard, occur in the May through September timeframe. There are currently two ozone standards that have been set by EPA to protect the public's health. The first standard is a 1-hour standard, which was set in 1977. The standard is set at 0.12 parts per million (ppm) ozone in the air. The Fayetteville Metropolitan Statistical Area has always met the 1-hour ozone standard.

The second standard is the new 8-hour ozone standard, set by EPA in 1997. This new standard is based on the maximum 8-hour average concentration and is set at .08 ppm. This compact is intended to address the new 8-hour standard and how the Fayetteville Metropolitan Statistical Area (MSA) will attain this new standard. There are two monitors in the Fayetteville MSA – one in the Town of Wade, and one in the Town of Hope Mills (Golfview), both of which are in Cumberland County. Both monitors currently violate the 8-hour ozone standard.

III. Current Air Quality Levels

Ozone data is evaluated over a three year period to determine compliance with the ozone standard. The current design value based on 2000 to 2002 ozone season data is as follows: Wade monitor - .087 ppm, Golfview monitor - .087 ppm. Table 1 presents the number of days that each monitor exceeded the 8-hour ozone standard over the most recent three years.

Table 1 Number of Days Over the 8-Hour Standard

Year	2000	2001	2002
Wade	4	2	17
Golfview	3	3	14

IV. Components of the Early Action Compact

A. Area Covered by the Compact

The area covered by this compact is the Fayetteville Metropolitan Statistical Area, which includes all of Cumberland County.

B. Participating Agencies in the Compact

The State agency will be the Department of Environment and Natural Resources. USEPA will be represented by the Region 4 office. At a minimum, the local agencies will be represented by the Chair of the Board of County Commissioners. (or designee) for the county. Other local organizations are invited to participate.

C. Requirements of the Early Action Compact

There are certain key requirements that will be addressed in the EAC and in the SIP development. These requirements are described in more detail below:

i. <u>Milestones and Reporting</u>

The EAC must identify key milestones and an associated schedule. The milestones include the development of the emissions inventories, base case modeling evaluation, identification of local measures, evaluation of local measures, adoption of local measures, and submittal of SIP incorporating local measures. Status reports are required every six months. The status reports must contain information regarding the completion of the milestones, or progress on an upcoming milestone.

ii. Emissions Inventory

The NC Department of Environment and Natural Resources (NCDENR) will be responsible for developing several emissions inventories for the project. Episode specific inventories will be developed for the July 1995, June 1996, and July 1997 events. Additionally, a current year inventory will be developed for 2000 or 2001 for purposes of applying the attainment test. Finally, future year inventory for 2007, 2012 and 2017 will also be developed.

iii. Modeling

The NCDENR will be responsible for conducting the meteorological and air quality modeling analysis. The NCDENR will conduct the modeling analysis based on USEPA's " Draft Guidance on the use of Models and Other Analyses in Attainment Determinations for the 8-hour Ozone NAAQS", May 1999 (EPA-454/R-99-004). The technical analysis will follow the guidance as facilitated by the EPA Regional office.

iv. Control Strategies

All of the signatories will participate in the evaluation and selection of control strategies. The Local agency signatories will primarily be responsible for the identification of the local measures. The NCDENR will be responsible for the state measures and for the development of the complete SIP including state and local measures.

v. Maintenance for Growth

A key component of the plan is the annual check of growth from the mobile and stationary source sector. In addition, a projection of growth to 2012 is required by the protocol. An additional projection of growth to 2017 will also be performed.

vi. Public Involvement

The development of the control measures and the SIP will be done through a public involvement process. Stakeholders from throughout the community will be invited to participate in this open process.

Fayetteville Area Early Action Compact
Memorandum of Agreement

This Early Action Compact (EAC) is a Memorandum of Agreement between the local government representing the county of Cumberland, the North Carolina Department of Environment and Natural Resources (NCDENR) and the United States Environmental Protection Agency (EPA). It is for the express purpose of developing and implementing an Early Action Plan (EAP) that will reduce ground-level ozone concentrations in the Fayetteville Metropolitan Statistical Area to comply with the 8-hour ozone standard by December 31, 2007, and maintain the standard beyond that date. Failure to meet these obligations results in immediate reversion to the traditional nonattainment process.

I. General Provisions

A. The signatory parties commit to develop, implement and maintain the EAP according to EPA Protocol for Early Action Compacts issued June 19, 2002, and adhere to all terms and conditions stated in the guidelines. See Appendix A for EPA Protocol for Early Action Compacts Designed to Achieve and Maintain the 8-Hour Ozone Standard.

B. If the region does not meet all the terms of the EAC, including meeting agreed-upon milestones, then it will forfeit its participation, deferral of the area's non-attainment designation will be withdrawn and its non-attainment designation for the 8-hour ozone NAASQ will become effective.

C. Before formal adoption into the SIP, this agreement may be modified or terminated by mutual consent of all signatory parties, or any party may withdraw from the agreement. The local government signatories will approve the local control measures before they are submitted to NCDENR for inclusion in the SIP. Once the EAP is incorporated into the SIP, any modifications will be treated as SIP revisions.

D. The signature date of the EAC is the start date of the agreement's term and the agreement remains in effect until December 31, 2007.

II. Local Government Responsibilities

The local government agrees to develop and implement a local EAP that will, when combined with State and Federal measures, demonstrate attainment by year's end 2007 of the 8-hour ozone standard and maintenance until at least 2012. The local government will develop this plan in coordination with NCDENR, EPA, stakeholders and the public. The EAP will include a process to monitor and maintain long-term compliance with the standard. The local government will develop and submit a list of control measures being considered for adoption as part of the EAP by June 16, 2003. The EAP will be submitted to NCDENR and EPA for review by January 31, 2004, and finalized by March 31, 2004, for inclusion in the SIP by December 31, 2004.

In the event a development or issue arises that may impact performance or progress toward milestones (including if a milestone will be or has been missed and/or if a termination or modification has been requested), the Fayetteville Area Metropolitan Planning Organization Staff, serving as the Lead Planning Agency, or the signatory party responsible will notify all other signatories as soon as possible.

III. The North Carolina Department of Environment and Natural Resources

The state, represented by NCDENR, will provide support to areas throughout the planning and implementation process, including:

1. Development of emission inventories, modeling process, trend analysis and quantification and comparison of emission reduction strategies;
2. Necessary information on all Federal and State adopted emission reduction strategies which affect the area;
3. Technical and strategic assistance, as appropriate, in the selection and implementation of emission reduction strategies;
4. Technical and planning assistance in developing and implementing processes to address the impact of emissions growth beyond the attainment date;
5. Maintenance of monitors and reporting and analysis of monitoring data;
6. Support for public education efforts;
7. Coordinate communication between local areas and EPA to facilitate continuing EPA review of local work;

8. Expeditious review of the locally developed EAP, and if deemed adequate, propose modification of the SIP to adopt the EAP;

9. Adoption of emission reduction strategies into the SIP as expeditiously as possible. The final complete SIP revision must be completed, adopted, and submitted by the state to EPA by December 31, 2004.

IV. The Environmental Protection Agency

1. The EPA will provide technical assistance to the state and local area in the development of the early action plan.

2. The EPA will take final action by September 30, 2005 on any SIP revisions submitted by December 31, 2004 pursuant to the compact

3. When EPA's 8-hour implementation guidelines call for designations, if the area has met the first two milestones (signed compact by December 31, 2002 and list of measures being considered for local adoption by June 16, 2003), EPA will defer the effective date of nonattainment designation and related requirements for participating areas that fail to meet the 8-hour ozone standard until September 30, 2005, contingent upon the area's submission of local control measures by March 31, 2004. As part of the SIP approval mentioned in item 2 above and assuming the SIP is approvable, EPA will propose as part of the SIP approval action, the second deferral of the effective date of non-attainment designation until December 31, 2006. If the June 30, 2006 progress assessment is submitted, implementation of the SIP measures have occurred, and air quality improvement is taking place, EPA will propose and, if appropriate, take final action on the third deferral of the effective date until April 15, 2008.

4. Provided that the monitors in the area reflect attainment by December 31, 2007, EPA will move expeditiously to designate the area as attainment and impose no additional requirements.

5. If at any time the area does not meet all the terms of this EAC, including meeting agreed-upon milestones, then it will forfeit its participation, deferral of the area's non-attainment designation may be withdrawn and its non-attainment designation will become effective. The EPA will offer such an area no delays, exemptions or other favorable treatment because of its previous participation in this program.

6. If the area violates the standard as of December 31, 2007, and the area has had a nonattainment designation deferred, the non-attainment designation will become effective no later than April 15, 2008. The state will then submit a revised attainment demonstration SIP revision according to the Clean Air Act (CAA) and EPA's 8-hour implementation rule, unless the 8-hour implementation schedule

requires SIPs from 8-hour non-attainment areas before December 31, 2008. In that event, a revised attainment demonstration SIP revision for the participating area will be due as soon as possible but no later than December 31, 2008. In no event will EPA extend the attainment date for the area beyond that required by the CAA and/or EPA's 8-hour implementation rule.

7. The region will not be allowed to renew this EAC after December 31, 2007, or to initiate a new compact if it has previously forfeited its participation.

V. The Protocol for Completing the EAP and the 8-Hour Ozone SIP

A. Milestones and Reporting

1. Milestones

EAC/CAAP Milestones (Responsible Party)	
December 31, 2002	Signed EAC (All parties)
May 31, 2003	Initial modeling emissions inventory completed (NCDENR)
	Conceptual modeling completed (NCDENR)
	Base case modeling completed (NCDENR)
June 16, 2003	Identify and describe local strategies being considered for inclusion in local clean air plans (Local Governments)
June 30, 2003	Biannual status reports to begin (Lead Planning Agency/NCDENR)
October 31, 2003	Future year emissions inventory modeling completed (NCDENR)
	Emissions inventory comparison and analysis completed (NCDENR)
	Future case modeling completed (NCDENR)
January 31, 2004	Attainment maintenance analysis completed (NCDENR)
	One or more modeled control cases completed (NCDENR)
	Local emission reduction strategies selected (Local Governments)
	Submission of preliminary EAP to NCDENR and EPA (Local Governments)
March 31, 2004	Final revisions to modeled control cases completed (NCDENR)
	Final revisions to local emission reduction strategies completed (Local Governments)
	Final revisions to attainment maintenance analysis completed (NCDENR)
	Submission of final EAP to NCDENR and EPA (Local Governments)
December 31, 2004	EAP adopted and incorporated into the SIP, SIP submitted to EPA (NCDENR)
December 31, 2005	Local emission reduction strategies implemented no later than this date (Implementing Agency)
June 30, 2006	Biannual status reports on implementation of measures begin on this date (Lead Planning Agency/NCDENR)
December 31, 2007	Attainment of the 8-hour standard no later than this date (All Parties)

2. Reporting

   In order to facilitate self-evaluation and communication with EPA, NCDENR, stakeholders, and the public, the region will assess and report progress towards milestones in a regular, public process, at least every six months.

B. Emissions Inventories

1. An **initial modeling emissions inventory** will be developed by May 31, 2003. This inventory will include:
   a. Emissions modeling data for a July 1995, June 1996 and July 1997 episode, all of which are representative of a typical ozone season event and meets EPA episode selection guidance;
   b. MOBILE6 data with link based Travel Demand Model (TDM) mobile data in urban areas;
   c. NONROAD model data adjusted for local equipment populations and usage rates where available;
   d. Area source data, based on local survey data, when possible.

2. A 2007 **future year modeling emissions inventory** will be developed by July 31, 2003. This inventory will sufficiently account for projected future growth in ozone precursor emissions through 2007, particularly from stationary, non-road and on-road mobile sources.

3. Selection of specific episode inventories was partially determined by the conceptual model, which reflects an analysis of meteorological conditions typical of high ozone events. The conceptual model will be updated by May 31, 2003.

4. Emissions inventories will be compared and analyzed for trends in emission sources over time. The **emissions inventory comparison and analysis** will be completed by October 31, 2003.

C. Modeling

1. **Base case modeling** will be completed by May 31, 2003 and **future case modeling** will be completed by October 31, 2003. One or more **modeled control cases** will be completed by January 31, 2004, with final revisions completed by March 31, 2004. All modeling:
   a. Will be SIP quality, consistent with the latest EPA modeling guidance, and performed within EPA's accepted margin of accuracy;

b. Will be carefully documented;
c. Will sufficiently account for projected future growth in ozone precursor emissions;
d. Will be accomplished by NCDENR and reviewed by EPA;
e. Will be used to determine the effectiveness of NOx and/or VOC reductions. The control case(s) will be used to determine the relative effectiveness of different emission reduction strategies and to aid in the selection of appropriate emission reduction strategies.

D. Emission Reduction Strategies

1. All adopted Federal and State emission reduction strategies that have been or will be implemented by the December 31, 2007 attainment date will be included in base, future and control case modeling.
2. Additional local emission reduction strategies needed to demonstrate attainment for the Fayetteville MSA by December 31, 2007 will be selected by January 31, 2004, with final revisions completed by March 31, 2004. The selected local strategies will be implemented as soon as practical, but no later than December 31, 2005.
3. Local emission reduction strategies will be specific, quantified, permanent and enforceable. The strategies will also include specific implementation dates and detailed documentation and reporting processes.
4. Voluntary strategies can play a supporting role in the EAP. If emission reductions from voluntary strategies are quantified and credit is taken for them in the EAP, those emission reductions will be enforceable. Additional strategies must be implemented to meet those quantified reduction requirements if quantified voluntary strategies fail. This is true for all quantified emission reductions, which must be made part of the SIP.
5. Local emission reduction strategies will be designed and implemented by the community with stakeholder participation.
6. Local emission reduction strategies will be incorporated by the state into the SIP. In the event that the region desires to add, delete or substitute strategies after SIP submittal, the region will request a modification. EAP modifications will be treated as SIP revisions and facilitated by the state.

E. Maintenance for Growth

1. The EAP will include a component to address emissions growth at least five years beyond December 31, 2007, ensuring that the area will remain in attainment of the 8-hour standard during that period. Attainment

maintenance analysis will be completed by January 31, 2004, with final revisions completed by March 31, 2004. The analysis will employ one or more of the following or any other appropriate techniques necessary to make such a demonstration:

a. Modeling analysis showing ozone levels below the 8-hour standard in 2012;
b. An annual review of growth (especially mobile and stationary source) to ensure emission reduction strategies and growth assumptions are adequate;
c. Identification and quantification of federal, state, and/or local measures indicating sufficient reductions to offset growth estimates.

2. A continuing planning process that includes modeling updates and modeling assumption verification (particularly growth assumptions) will be conducted concurrent with the tracking and reporting process for the EAP. This update and verification will be an ongoing process between the signatories, stakeholders and the public. Modeling updates and planning processes must consider and evaluate:
   a. All relevant actual new point sources;
   b. Impacts from potential new source growth; and
   c. Future transportation patterns and their impact on air quality in a manner that is consistent with the most current adopted Long Range Transportation Plan and most current trend and projections of local motor vehicle emissions.

3. If the review of emissions growth in conjunction with the continuing planning process demonstrates that adopted emission reduction strategies are inadequate to address growth in emissions, additional measures will be added to the EAP.

4. In the event that the continuing planning process identifies the need to add, delete, or substitute emission reduction strategies after the EAP has been incorporated into the SIP, the local area will initiate, and NCDENR will facilitate a SIP revision to accommodate changes.

F. Public Involvement

1. Public involvement will be conducted in all stages of planning by the signatory parties. Outreach may include one or more of the following

techniques: public meetings and presentations, stakeholder meetings, websites, print advertising and radio.

2. Public education programs will be used to raise awareness regarding issues, opportunities for involvement in the planning process, implementation of emission reduction strategies, and any other issues important to the area.

3. Interested stakeholders will be involved in the planning process as early as possible. Planning meetings will be open to the public, with posted meeting times and locations. EAP drafts will be publicly available, and the drafting process will have sufficient opportunities for comment from all interested stakeholders.

4. Public comment on the proposed final EAP will follow the normal SIP revision process as implemented by the State.

5. Semi-annual reports detailing, at a minimum, progress toward milestones, will be publicly presented and publicly available.

VI. Signatures:

Talmage S. Baggett, Jr. Chairman County of Cumberland Board of Commissioners	J.I. Palmer, Jr. Administrator, Region 4, U.S. Environmental Protection Agency
William G. Ross, Jr. Secretary, North Carolina Department of Environment and Natural Resources	

APPENDIX C – LOCAL GOVERNMENT ADOPTIONS

The local governing bodies adopted selected strategies on the dates listed below. Minutes are available upon request.

Town of Falcon:	August 4, 2003
Town of Linden:	August 19, 2003
Town of Stedman:	September 4, 2003
Town of Spring Lake:	September 8, 2003
Town of Wade:	September 9, 2003
Town of Godwin:	September 15, 2003
Cumberland County:	October 6 and December 15, 2004
Town of Hope Mills:	November 12, 2003
City of Fayetteville:	February 2, 2004

APPENDIX D –MODEL, EPISODE AND METEREOLOGY

1 INTRODUCTION

As a requirement of the Fayetteville Early Action Compact (EAC), the progress report due June 30, 2003, must include a status report regarding the air quality modeling. This report satisfies this requirement. Discussed in this report are the photochemical model selection, episode selection, meteorological model development, emissions inventory development, and the modeling status.

The modeling system being used for this demonstration and the episodes being modeled are discussed below in further detail in Sections 2 and 3.

The modeling analysis is a complex technical evaluation that begins by selection of the modeling system and selection of the meteorological episodes. North Carolina Division of Air Quality (NCDAQ) decided to use the following modeling system:

- Meteorological Model: MM-5 – This model generates hourly meteorological inputs for the emissions model and the air quality model, such as wind speed, wind direction, and surface temperature.

- Emissions Model: Sparse Matrix Operator Kernel Emissions (SMOKE) - This model takes daily county level emissions and temporally allocates across the day, spatially locates the emissions within the county, and transfers the total emissions into the chemical species needed by the air quality model.

- Air Quality Model: MAQSIP (Multi-Scale Air Quality Simulation Platform) – This model takes the inputs from the emissions model and meteorological model and predicts ozone hour by hour across the modeling domain, both horizontally and vertically.

The following historical episodes were selected to model because they represent typical meteorological conditions in North Carolina when high ozone is observed throughout the State:

- July 10-15, 1995
- June 20-24, 1996
- June 25-30, 1996
- July 10-15, 1997

The meteorological inputs were developed using MM5 and are discussed in detail in Section 4.

The precursors to ozone, Nitogen Oxides (NOx), Volatile Organic Compounds (VOCs), and Carbon Monoxide (CO) were estimated for each source category. These estimates were then spatially allocated across the county, temporally adjusted to the day of the week and hour of the day and speciated into the chemical species that the air quality model needs to predict ozone. The development of the emission inventories are discussed in detail in Section 5.

The status of the modeling work and the issues that have been encountered are discussed in Section 6.

2 MODEL SELECTION

2.1 Introduction

To be useful in a regulatory framework, photochemical grid models and their applications must be defensible. Not only must the U.S. Environmental Protection Agency (EPA) be convinced of this, but members of the regulated community (stakeholders) as well. Failure to convince EPA can result in rejection of an implementation or maintenance plan. Failure to convince the regulated community can lead to diminished rule effectiveness and litigation. In none of these cases are the state's air quality goals advanced.

> To ensure that a modeling study is defensible, care must be taken in the selection of the models to be used. The models selected must be scientifically appropriate for the intended application and be freely accessible to all stakeholders. Scientifically appropriate means that the models address important physical and chemical phenomena in sufficient detail, using peer reviewed methods. Freely accessible means that model formulations and coding are freely available for review and that the models are available to stakeholders, and their consultants, for execution and verification at no or low cost.

In the following sections we outline the criteria for selecting a modeling system that is both defensible and capable of meeting the study's goals.

2.2 Selection of Photochemical Grid Model

2.2.1 Criteria

For a photochemical grid model to qualify as a candidate for use in an attainment demonstration of the 8-hour ozone National Ambient Air Quality Standards (NAAQS), a State needs to show that it meets several general criteria.

- The model has received a scientific peer review
- The model can be demonstrated applicable to the problem on a theoretical basis
- Data bases needed to perform the analysis are available and adequate
- Available past appropriate performance evaluations have shown the model is not biased toward underestimates
- A protocol on methods and procedures to be followed has been established
- The developer of the model must be willing to make the source code available to users for free or for a reasonable cost, and the model cannot otherwise be proprietary

2.2.2 Overview of MAQSIP

The photochemical model selected for this study is the Multiscale Air Quality SImulation Platform (MAQSIP). MAQSIP is a fully modularized three-dimensional system with various options for representing the physical and chemical processes describing regional- and urban-scale atmospheric pollution. The governing model equations for tracer continuity are formulated in generalized coordinates, thereby providing the capability of interfacing the model with a variety of meteorological drivers. The model employs flexible horizontal grid resolution with multiple multi-level nested grids with options for one-way and two-way nesting procedures. In the vertical, the capability to use non-uniform grids is provided. Current applications have used horizontal grid resolutions from 18-80 km for regional applications and 2-6 km for urban scale simulations, and up to 30 layers to discretize the vertical domain.

The MAQSIP framework with the detailed gas-phase and aerosol model provides a modeling system that can be used for investigating the various processes that govern the loading of chemical species and anthropogenic aerosols at various scales of atmospheric motions from urban, regional to intercontinental scales. For example, MAQSIP has been used to support the Southeastern States Air Resources Management (SESARM) project to produce seasonal simulations of ozone over eastern United States. The gas-aerosol version of the MAQSIP (hereinafter the MAQSIP-PM) has been used in urban-to-regional-scale applications over the eastern and western United States, and western Europe, to study the production and distribution of fine and coarse PM, and its effects on visibility and the radiation budget.

For regulatory application, a specific configuration of MAQSIP has been used in this study. This configuration of MAQSIP follows a series a sensitivity tests to determine the best performing modules. This configuration has the following components:

- Horizontal Coordinate System: *Lambert Conformal Projection*
- Vertical Coordinate System: *Non-Hydrostatic Sigma-Pressure Coordinates*
- Gas Phase Chemistry: *Carbon Bond IV with Isoprene updates*
- Aqueous Phase Chemistry: *Included in cloud package*
- Chemistry Solver: *Modified QSSA*
- Horizontal Advection: *Bott*
- Cloud Physics: *Kain-Fritsch parameterization and explicit, as needed*
- Horizontal Turbulent Diffusion: *Fixed* K_h
- Vertical Turbulent Diffusion: *K-Theory*
- Photolysis Rates: *Madronich*
- Dry Deposition: *Resistance*
- Wet Deposition: *Included in cloud package*

2.3 Selection of Meteorological Model

2.3.1 Criteria

Meteorological models, either through objective, diagnostic, or prognostic analysis, extend available information about the state of the atmosphere to the grid upon which photochemical grid modeling is to be carried out. The criteria for selecting a meteorological model are based on both the models ability to accurately replicate important meteorological phenomena in the region of study, and the model's ability to interface with the rest of the modeling systems -- particularly the photochemical grid model. With these issues in mind, the following criteria were established for the meteorological model to be used in this study:

- Non-Hydrostatic Formulation
- Reasonably current, peer reviewed formulation
- Simulates Cloud Physics
- Publicly available on no or low cost
- Output available in I/O API format
- Supports Four Dimensional Data Assimilation (FDDA)
- Enhanced treatment of Planetary Boundary Layer heights for AQ modeling

2.3.2 Overview of MM5

The meteorological model selected for this study is the nonhydrostatic PSU/NCAR Mesoscale Model Version 5 (MM5). MM5 (Dudhia 1993; Grell et al. 1994) is one of the leading three-dimensional prognostic meteorological models available for air quality studies. It uses an efficient split semi-implicit temporal integration scheme and has a nested-grid capability that can use up to ten different domains of arbitrary horizontal resolution. This allows MM5 to simulate local details with high resolution (as fine as ~1 km), while accounting for influences from great distances, using horizontal resolutions ranging to about 200 km.

MM5 uses a terrain-following nondimensionalized pressure, or "sigma", vertical coordinate similar to that used in many operational and research models. In the nonhydrostatic MM5, the sigma levels are defined according to the initial hydrostatically balanced reference state so that these levels are also time-invariant. The meteorological fields also can be used in other photochemical grid models with different coordinate systems by performing a vertical interpolation followed by a mass-consistency reconciliation step.

The model contains two types of planetary boundary layer (PBL) parameterizations suitable for air-quality applications, both of which represent subgrid-scale turbulent fluxes of heat, moisture, and momentum. A modified Blackadar PBL (Zhang and Anthes 1982) uses a first-order eddy diffusivity formulation for stable and neutral environments and a nonlocal closure for unstable regimes. The Gayno-Seaman PBL (Gayno, 1994) uses a prognostic equation for the second-order turbulent kinetic energy, while diagnosing the other key boundary layer terms. This is referred to as a 1.5-order PBL, or level-2.5, scheme (Mellor and Yamada 1974).

Initial and lateral boundary conditions are specified for real-data cases from mesoscale 3-D analyses performed at 12-hour intervals on the outermost grid mesh selected by the user. Surface fields are analyzed at three-hour intervals. A Cressman-based technique is used to analyze standard surface and radiosonde observations, using the National Meteorological Center's spectral analysis, as a first guess (Benjamin and Seaman 1985). The lateral boundary data are introduced using a relaxation technique applied in the outermost five rows and columns of the coarsest grid domain.

For most traditional (1-hour standard) high-ozone episodes, precipitation is not the dominant factor. On the other hand, precipitation events may have a greater impact on 8-hour average ozone episodes. The MM5 contains five convective parameterization schemes (Kuo, Betts-Miller, Fritsch-Chappell, Kain-Fritsch, and Grell). It also has an explicit resolved-scale precipitation scheme (Dudhia 1989) that solves prognostic equations for cloud water/ice (q_c) and larger liquid or frozen hydrometeors (q_r). In addition the model contains a short- and long-wave radiation parameterization (Dudhia 1989).

2.4 Selection of Emissions Processing System

2.4.1 Criteria

The principal criterion for an emissions processing system is that it accurately prepares emissions files in a format suitable for the photochemical grid model being used. The following list includes clarification of this criterion and additional desirable criteria for effective use of the system.

- File System Compatibility with the I/O API
- File Portability
- Ability to grid emissions on a Lambert Conformal projection
- Report Capability
- Graphical Analysis Capability
- MOBILE6 Mobile Source Emissions
- BEIS-2 Biogenic Emissions
- Ability to process emissions for the proposed domain in a day or less.
- Ability to process control strategies
- No or low cost for acquisition and maintenance
- Expandable to support other species and mechanisms

2.4.2 Overview of SMOKE

The emissions processing system selected for this study is the Sparse Matrix Operator Kernel Emissions (SMOKE). SMOKE was developed to reduce the large processing times required to prepare emissions data for photochemical grid models. SMOKE processes both anthropogenic and biogenic emissions. Biogenic emissions are processed using an implementation of BEIS-3.

The modular structure of SMOKE (see Appendix A) removes much of the redundant processing found in other systems. This will provide even greater savings of CPU time and disk space when SMOKE is used to process control strategies. Unlike other emission processing systems, SMOKE's structure makes each process (i.e., gridding, speciation, temporal allocation, and control application) independent from the others. For example, to run a new control strategy, only the control model must be rerun, and the time-stepped emissions multiplied by the matrices. This whole process takes only a few minutes to process a new point source strategy and a few additional minutes if area and mobile sources are also changed.

SMOKE has undergone an extensive process of testing and validation. It has been validated on a regional scale against EMS-95 using the OTAG 1990 inventory, and on a large urban scale against EPS 2.0 using North Carolina's State Implementation Plan (SIP) inventory. SMOKE can be driven with inputs in either EMS-95, EPS 2.0 or IDA format, and it can produce photochemical grid model-ready emissions in forms suitable to drive UAM-IV, UAM-V, MAQSIP, CMAQ and SAQM. SMOKE has adopted the Models-3 Input/Output Application Program Interface (I/O API) so the emissions files created by SMOKE are directly readable by Models-3, MCNC's MAQSIP, and the supporting analysis tools developed for these systems.

3 EPISODE SELECTION

3.1 Introduction

The episode selection process is critical to the success of the modeling study. Correctly identifying representative ozone episodes to model for several areas in North Carolina allows us to evaluate with confidence various control strategies for maintaining the NAAQS for ozone. Several factors influenced episode selection for this modeling study. In the following sections we outline the factors and considerations for episode selection, and then outline in detail the episodes selected for this modeling study.

3.2 Factors Influencing Episode Selection

Several factors influenced episode selection for this modeling study. The primary factor influencing episode selection was the promulgation of an 8-hour standard for ozone and the litigation that followed. This led to uncertainties surrounding the implementation of the standard. Also, the form of the new 8-hour standard makes it less dependent on extreme events than the 1-hour standard. Therefore, meteorological scenarios associated with 8-hour exceedances were reviewed and considered for modeling. A combination of these factors led to choosing episodes where both the 1-hour and 8-hour standards were exceeded.

The EPA issued a new ambient air quality standard based on the daily maximum 8-hour averaged concentration for ozone in July 1997. In June of 1998, EPA revoked the 1-hour standard in North Carolina since all areas of the state had attained that standard. However, in the 1998 ozone season, North Carolina experienced its first violation of the 1-hour ozone standard since 1990 in the Charlotte area. Later, in May 1999, a D.C. District Court ruling instructed EPA that an intelligible principle for the setting of the new 8-hour standard had to be defined and that enforcement of the 8-hour standard was prohibited by the court until EPA had done so. In 1999, EPA reinstated the old 1-hour standard. The result of all of the changing policy and litigation is that the modeling study must shift its primary focus from a traditional analysis solely targeted at 1-hour averaged ozone values, to an analysis of both 1-hour and 8-hour averaged values. Analysis of episodes with exceedances of 1-hour and 8-hour standards will also allow an assessment of the differences that two standards may have on control strategy development and will indicate whether control strategies designed to meet the 8-hour standard will also be effective at reducing ozone levels below the 1-hour standard. The "dual" need to model 1-hour and 8-hour exceedances was a primary criterion in the episode selection process.

A second factor affecting the selection process was the form of the new standard. The 1 hour standard allowed 1 exceedance per year in a region on average with the design value being the 4th highest 1 hour value in that region over 3 years. This means that, in theory, only the 3 worst case episodes in a 3-year period can be removed from consideration for modeling. The design value under the 8-hour standard is calculated differently. It is the yearly 4th highest 8-hour value at each monitor, averaged over 3 years. With the new standard it is possible to "throw out" the 3 worst case episode days of each year, or approximately 9 days over 3 years for each monitor. Because the 4th high value is determined for each individual monitor, discarding days with higher values can result in the removal of more than 9 worst case days if the high readings for all monitors do not occur on the same days. For example, exceedances may be measured north of a city during days when the wind blows predominately from the south, but measured at monitors south of the city on other days when winds are northerly. Discarding days above the 4th highest measurement in this example could result in removal of more than 9 worst case episode days in three years. This makes the standard less dependent on extreme events.

3.3 Episode Selection Considerations

The methodologies suggested in EPA's draft guidance for episode selection is the same for both the 1-hour and 8-hour standards. These methodologies were applied to the extent possible when attempting to choose episodes. The episode selection criterion was compromised to some extent by the need to simultaneously model multiple areas in North Carolina.

First, we considered a mix of episodes reflecting a variety of meteorological scenarios which frequently correspond with observed 8-hour daily maxima > 84 ppb at different monitoring sites. An analysis of each ozone episode was made using several sources of air quality and meteorological data to determine the episodes that would contribute the most to the modeling effort.

Secondly, we considered periods in which observed 8-hour daily maximum concentrations were within ±10 ppb of each area's design value. Because modeling for the new 8-hour standard may capture some 1-hour exceedances, 8-hour averaged ozone concentrations were given primary consideration. The 8-hour design values were calculated statewide, with a focus on the three major urban areas of NC; Charlotte/Gastionia, Greensboro/Winston-Salem (the Triad), and Raleigh/Durham (RDU), using monitored values from 1994-2002. The average of each year's fourth highest daily 8-hour averaged maximum concentration for each monitor statewide was calculated and used as a guide for determining the episodes with concentrations within ±10 ppb of the area's design value.

Finally, the temporal and spatial distribution of ozone throughout NC was also an important consideration. The new 8-hour standard brings areas such as Asheville, Fayetteville, Greenville/Rocky Mount/Wilson (Down East), Hickory, and other various areas into non-attainment. Therefore, it was necessary to choose episodes affecting those areas as well as the three major urban areas mentioned above. Episodes containing widespread ozone exceedances were given priority over those containing isolated exceedances. Also, the need to study the cumulative effects of ozone build-up over a number of days was recognized, so episodes of extended duration were given preference over single day exceedances.

Meeting all of the criteria in all areas is sometimes difficult. The episode selection criterion was compromised to some extent by the need to simultaneously model multiple areas. For example, during many "moderate" ozone events, ozone exceedances are not widespread throughout NC. Selection of these episodes can dramatically increase the number of modeled episodes needed to complete a thorough analysis of all non-attainment areas across the state. On the other hand, episodes with exceedances in all non-attainment areas often contain scattered extreme values.

To reduce the number of episodes to a manageable number, while also performing a complete analysis on each major urban area of NC, we made some compromise in the selection criteria. Ideally, no days with concentrations well above an area's design value would have been included in the selected episodes. However, on some days concentrations in one or two areas were found to be ideal for modeling while another area had observed concentrations well above its' ozone design value. Days such as these were included in the selected episodes due to the days' overall positive attributes.

3.4 Episode Selection Procedures

Ambient data was used to determine the days that exceedances of the 1-hour and/or 8-hour standard occurred in any of the major urban areas of NC from 1995 through 1997. These days were grouped into episodes and evaluated using the selection criteria discussed in the preceding section. An analysis of each ozone episode was made using several sources of air quality and meteorological data to determine the episodes that would contribute the most to the modeling effort.

Sets of ambient ozone data from 1995-1997 for the eastern US were plotted using Voyager Viewer software. The data were plotted for the eastern US using both hourly and 8-hour peak ozone concentrations. This permitted easy assessment of the spatial and temporal distribution of ozone throughout North Carolina as well as other areas of the eastern US and made it possible to easily determine whether the event was regional, sub-regional, or local in nature. These plots combined with meteorological plots also indicated the potential for recirculation. In one episode, shifts in wind direction corresponded to shifts in the location of ozone peaks in the Charlotte area, suggesting that recirculation may have contributed to exceedances of both ozone standards.

In addition to the ambient data plots, several surface and upper air meteorological data sets were used to assess the atmospheric conditions contributing to the build-up of ozone in each episode. Local Climatological Data sheets were used to collect diurnal data on temperatures, precipitation, and wind speed and direction. Daily weather maps were used to determine the location of surface fronts, troughs, and ridges as well as daily peak temperatures, precipitation, and the location of high and low pressure areas. Analysis charts (0000 Z and 1200 Z) for the surface, 850 mb, 700 mb, and 500 mb levels from the

NOAA-NCEP ETA meteorological computer model were also used to assess conditions such as surface and upper air wind fields, temperatures, moisture, and the location of ridges and troughs. The conditions contributing to high levels of ozone were determined through chart analysis, and the type of meteorology was used to group episodes.

3.5 Episode Selection

All days with ozone exceedances in any of the major urban areas of NC were considered in the episode selection process. These days were divided into episodes based on the distribution of measured ozone and the meteorological conditions that occurred throughout the period of exceedance. The meteorological characteristics of each episode were studied using the tools outlined in the previous section. All episodes will have some common characteristics. Warm temperatures, little or no precipitation, and relatively light winds are needed to produce ozone episodes. Typically, those conditions are characteristic of a surface high-pressure area. The differences in the position, strength, and movement of the surface high-pressure areas, along with differences in the mid-to-upper level wind patterns, allow us to discern several meteorological scenarios in which ozone episodes are likely. These meteorological scenarios are discussed in the following paragraphs.

Conditions that traditionally lead to large-scale exceedances of the 1-hr standard result from the development of a broad surface high pressure area sprawled over the eastern third of the US and a large mid-to-upper level high pressure area near the Midwest (Scenario 1 – Eastern Stacked High). The mid-to-upper level ridge blocks the movement of fronts into the Eastern US and often results in very hot temperatures, little precipitation, and the buildup of high 1-hr and 8-hr ozone concentrations over much of the Midwest, Northeast, and South. As the mid-to-upper level ridge slowly slides eastward, it situates itself over the surface high-pressure creating a "stacked high" over the Eastern US. The resulting large-scale subsidence leads to very low vertical mixing heights prohibiting dispersion of precursor pollutants. The stagnant air mass from the "stacked high" scenario is prime for ozone episodes in the Eastern US. A trough can develop in east/central NC during this scenario producing south-southwesterly flow east of the trough and causing a large ozone concentration gradient. The presence of the trough can limit ozone readings east of the trough axis below the 1-hour and 8-hour standards throughout the episode. (An example of these conditions is recorded in the July 14, 1995 Daily Weather Map [Figure 3.5-1]. The 500-mb chart clearly shows the presence of a large high pressure area over the Midwest.)

The most frequently occurring meteorological scenario (Scenario 2 – Frontal Approach) is characterized by the movement of cold fronts toward NC and the presence of high pressure to the south or southwest of the state. Cold fronts often move toward NC during the summer months but are typically not strong enough to move completely through the state. They commonly become east-west oriented and stall as far south as southern Virginia or northern sections of NC. The front may dip into northern portions of NC and then retreat as a warm front creating wind shifts or re-circulation patterns. A southwesterly surface flow predominates as the front approaches, but as the front moves into northern sections of NC, winds become more northerly. When the front retreats back to the north as a warm front, southwesterly winds return to the entire state. In the meantime, a zonal flow exists in the mid-to-upper levels. High temperatures range from the low to upper 90's and dew points are in the upper 60's to mid 70's. Scattered exceedances of the 1-hour standard and widespread exceedances of the 8-hour standards may be realized in NC during these conditions. (These conditions can be seen in the June 23, 1996 Daily Weather Map in [Figure 3.5-2]. Note the presence of a stationary front along the NC/VA border.)

A third meteorological scenario (Scenario 3 – Canadian High) resulting in high buildups of ozone in NC is characterized by a surface high-pressure area building in from the north, and a mid-to-upper level ridge that builds and sprawls to the west of NC in the Mid-Mississippi Valley area. The position of the mid-to-upper level ridge produces a northerly flow aloft throughout this scenario. As the Canadian-born surface high-pressure builds into NC, it brings with it milder and drier air by means of a north-northeasterly breeze. These conditions can lead to scattered exceedances of the 8-hour standard in NC. Temperatures are typically in the low to mid 80's (with dew points in the low to mid 60's) during the beginning of this type of episode. However, as the center of the surface high-pressure slides into NC, and the winds become light and variable, highs may reach the upper 80's to low 90's (with dew points in the upper 60's to low 70's). Scattered exceedances of the 1-hour standard and widespread exceedances of the 8-hour standards may be realized in NC during these conditions. (An example of these conditions is shown in Figure 3.5-3 [June 28, 1996].)

The fourth meteorological scenario (Scenario 4 – Modified Canadian High with slight Tropical Influence), initially, is very similar to Scenario 3 above. Canadian born surface high-pressure builds into NC delivering lower dew points and milder temperatures with a light north-northeasterly wind. This cool down is short-lived however. As the high-pressure center moves south of NC, a light southwesterly flow dominates, temperatures soar, and dew points increase. A mid-to-upper level ridge slowly sprawls eastward across the country, resulting in a very weak flow aloft. Occasionally, when the mid-to-upper level flow is very weak along the East Coast during the mid-to-late summer, tropical systems that work their way across the Atlantic Ocean can approach the Southeast US. Although it does not occur frequently, a tropical system lurking off the Carolina coast may influence conditions over NC in the form of subsidence in the mid-to-upper levels. Subsidence is usually distributed over a wide area away from tropical systems, and leads to cloudless skies and hot dry weather. The strength and proximity of the tropical system will influence the magnitude and extent of the subsidence and its' role in ozone formation in NC. (An example of these conditions is shown in Figure 3.5-4 [July 14, 1997].)

Meteorological scenarios other than the four identified above can result in ozone episodes. These "other" episodes, however, commonly do not meet the temporal or spatial requirements of the episode selection criteria for modeling defined in the U.S. EPA Draft Modeling Guidance for Ozone Attainment Demonstrations. One-day ozone episodes can occur during a progressive meteorological pattern (Scenario 5 – Continental High in a progressive pattern). A surface high-pressure area moving across the US and into NC for one day characterizes this scenario. This results in clear skies, light winds, and isolated 8-hour ozone exceedances.

An initial analysis of ambient data and Daily Weather Maps was used to place each of the ozone episodes into one of the four meteorological scenarios identified above. A list of the number of monitors with exceedances of the 8-hour standard in each of the major urban areas was compiled and reviewed. This information was used to exclude those episodes from each category that did not have sufficient spatial or temporal distribution to justify further study. A more detailed analysis of each of the remaining episodes was made using all sources of air quality and meteorological data to select the episodes that would best meet modeling objectives.

To better understand the impact of emission controls under the full range of meteorological conditions, one episode from each meteorological scenario was selected for modeling. The four episodes were selected because they represented a good cross-section of events from both an air quality and meteorological perspective. They were also selected because observed ozone concentrations were close to the areas design value, and high ozone values were widespread throughout NC. One episode was selected from 1995 (Scenario-1), two from 1996 (Scenario-2 & Scenario-3), and one from 1997 (Scenario-4). The two episodes selected from 1996 were separated by only two days during which time a strong cold front cleaned out the atmosphere as it passed through the state. The two episodes will be modeled simultaneously. This presents a good opportunity to test the ability of the air quality model to produce clean conditions in the middle of an episode.

These episodes provide a wide range of conditions that will provide the basis for a thorough analysis of the variety of factors that lead to ozone exceedances in NC. Control strategies can be tested under conditions that range from short duration ozone peaks above the 1-hour standard to extended periods of moderate levels of ozone producing widespread exceedances of the 8-hour standard. These episodes also range from multi-regional to exceedances confined primarily to the state of NC.

The first episode (Episode-E1) is a 3-day episode that occurred from June 13 – 15, 1995. (See the July 14 Daily Weather Map in Figure 3.5-1.) This episode was modeled by the Northeast Modeling Center as part of the OTAG study of ozone transport. This episode is a traditional ozone episode with high 1-hour and 8-hour averages throughout almost all areas of the South, East, and Midwest. A very strong upper level ridge developed to the west of NC and moved slowly to the east throughout the episode. On July 15th, the 1-hour peak reached 166 ppb in Atlanta, 179 ppb in Baltimore, and 154 ppb near Chicago. The highest readings were recorded in NC on July 14th; 129 ppb in Charlotte (99 ppb 8-hour) and 130 ppb in the Triad area (112 ppb 8-hour). A trough developed in eastern NC on July 14th producing south-southwesterly flow east of the trough and causing a large ozone concentration gradient. Although a 1-hour peak of 129 ppb was measured in Charlotte, the peak ozone was only 39 ppb 100 miles to the east. The presence of the trough kept ozone readings in the Raleigh/Durham area below the 1-hour and 8-hour standards throughout the episode. The trough moved to the west on July 15th and dropped 1-hour averages in Charlotte and the Triad below the standard; however, 8-hour concentrations remained above 0.085 ppm.

The first 1996 episode (Episode-E2) occurred June 21 – 24 1996. It is primarily a NC episode. (See the June 23 Daily Weather Map in Figure 3.5-2.) Concentrations in most other areas of the South and East were lower than those in NC. This episode is dominated by the presence of a front to the north and high pressure to the southwest of the state. The movement of the front and the monitored ozone readings indicate possible recirculation during the episode. Light southwesterly flow was present on 22 June and resulted in a 1-hour/8-hour peak of 133/110 ppb and 113/99 ppb northeast of Charlotte and Durham, respectively. As the front moved into northern portions of NC on the 23rd, winds became more northerly and concentrations in the Triad and Raleigh/Durham area's fell. Ozone and precursor pollutants were pushed back into Charlotte and resulted in exceedances of the 1-hour and 8-hour standard at all three Mecklenburg county ozone monitors. On the 24th, the front retreated north as a warm front and southwesterly winds returned to the entire state. Ozone levels increased throughout northern portions of NC and 8-hour averaged concentrations between 90 and 100 ppb were recorded in the major urban areas of the Piedmont. One exceedance of the 1-hour standard (134 ppb) was measured at the Rockwell site, northeast of Charlotte.

A stronger front moved toward NC on the 25th touching off storms and dropping ozone readings. The front passed through the state by the 26th and concentrations remained low. An upper level ridge began to build to the west of NC and surface high pressure over Canada moved southward throughout episode (Episode-E3) (June 27 – 29, 1996) and settled into western NC by the 29th. (See the June 28 Daily Weather Map in Figure 3.5-3.) Northerly winds were predominant at the surface and upper levels. High temperatures remained 90 and below in NC and much of the eastern half of the US during this period. Dew point temperatures were relatively low and winds were light enough to produce 8-hour exceedances in many areas of NC on the 28th and 29th. As high pressure remained over western NC, ozone concentrations continued to rise throughout the episode. Exceedances of the 1-hour standard were measured at two monitors in Charlotte on the 29th.

The final episode selected for analysis (Episode-E4) occurred July 11 – 15, 1997. (See the July 14 Daily Weather Map in Figure 3.5-4.) The previous three episodes did not capture typical ozone behaviors in the center city areas of the Triad and the Triangle. The selection of this episode also was driven by the need to model an episode that captured ozone events in areas such as Greenville, Fayetteville, and Hickory. The most distinctive aspect of this episode, however, is that a 1-hour exceedance occurred in the Triangle area on the July 14th. No other episode captures a 1-hour exceedance in this region. On the first three days of the episode, meteorological conditions were very similar to those in episode E3. On the 14th and 15th, however, the surface high-pressure center moved over NC, the mid-to-upper level flow relaxed, and a tropical depression off the NC coast strengthens into Tropical Storm “Claudette”. It is possible that the tropical system influenced conditions in NC (especially Eastern NC) on the 14^{th} and 15^{th}. Temperatures soared into the mid 90's with dew points in the mid-to-upper 60s. The backward air parcel trajectories from Rocky Mount, NC (shown in Figure 3.5-5), illustrates the possible influence from the tropical system (Note the subsidence at mid-levels from 0Z –20Z on the 14^{th}.) Exceedances of the 8-hour standard were recorded in North Carolina, South Carolina and Virginia as the surface high-pressure center moved over NC, the mid-to-upper level flow aloft weakened, and the tropical system made it's nearest approach.

Figure 3.5-1 Daily Weather Maps for July 14, 1995

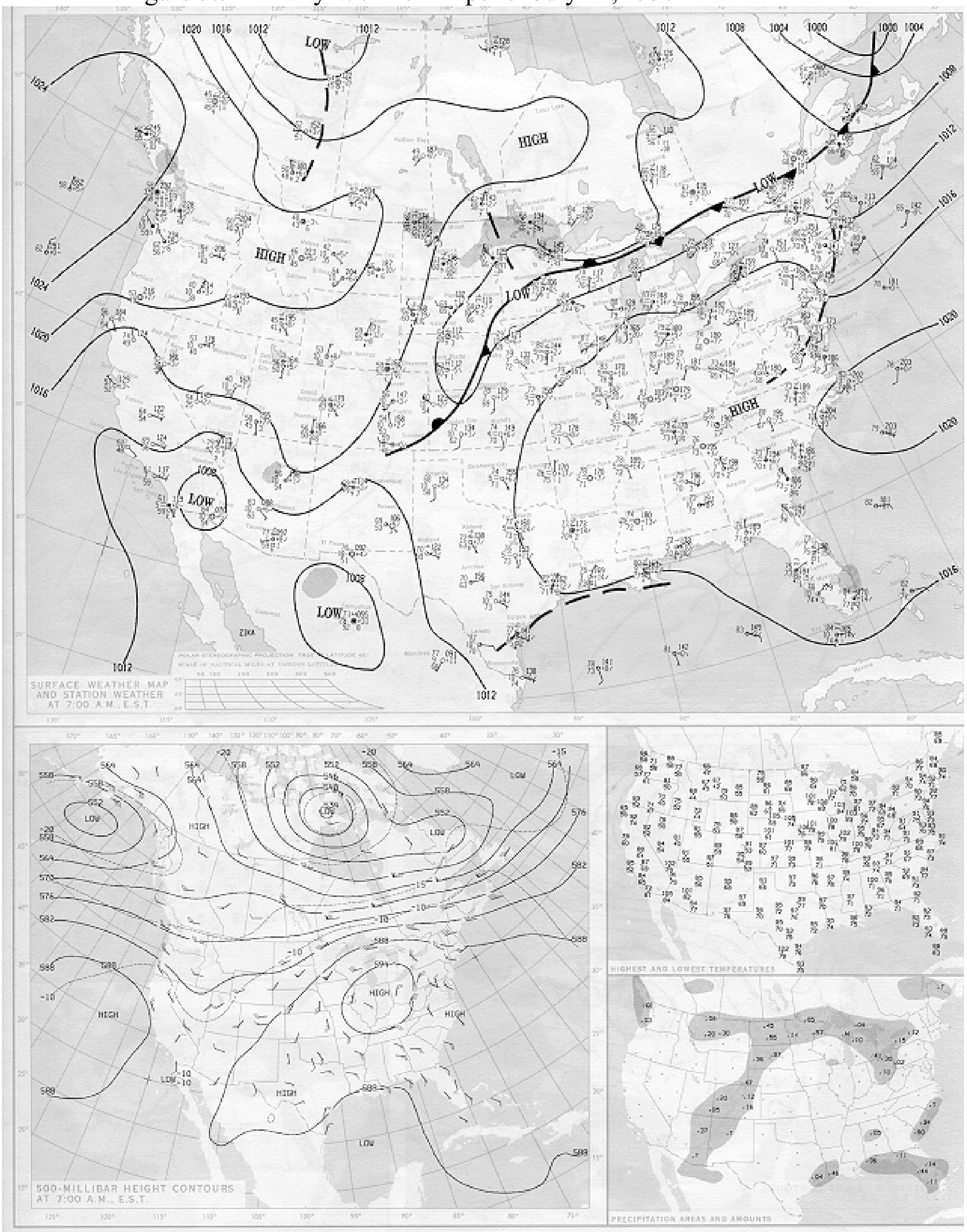


Figure 3.5-2 Daily Weather Maps for June 23, 1996

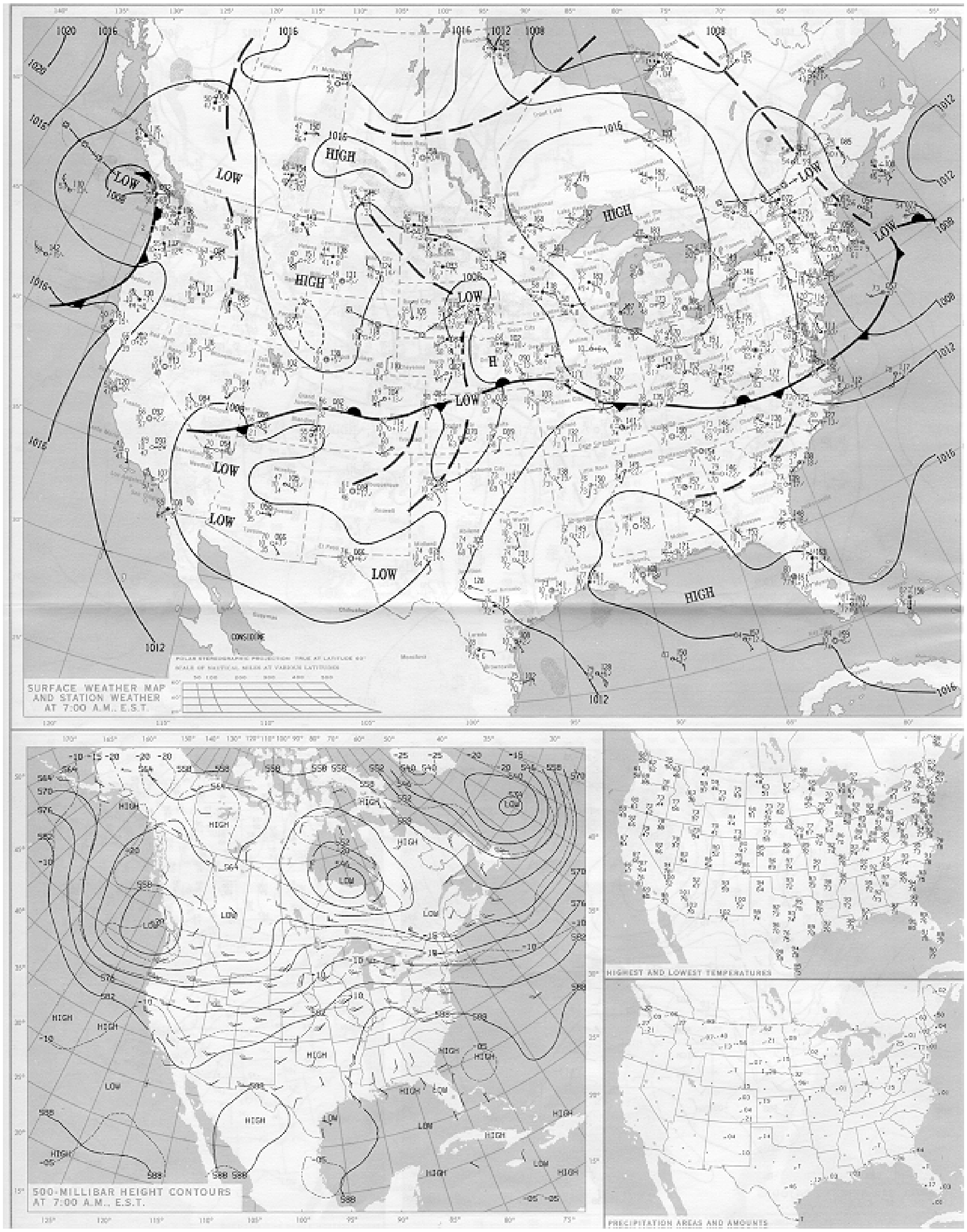


Figure 3.5-3 Daily Weather Maps for June 28, 1996

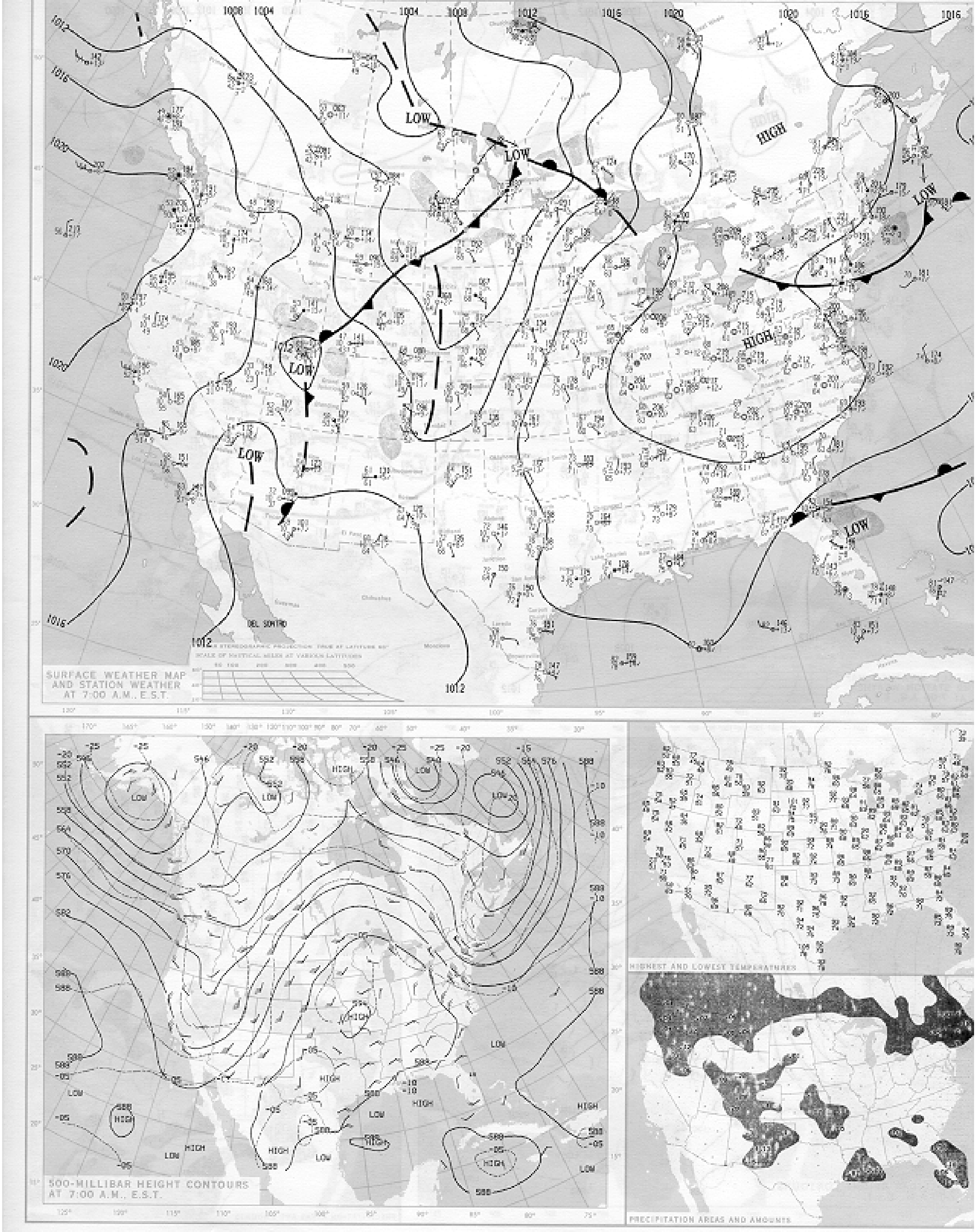


Figure 3.5-4 Daily Weather Maps for July 14, 1997

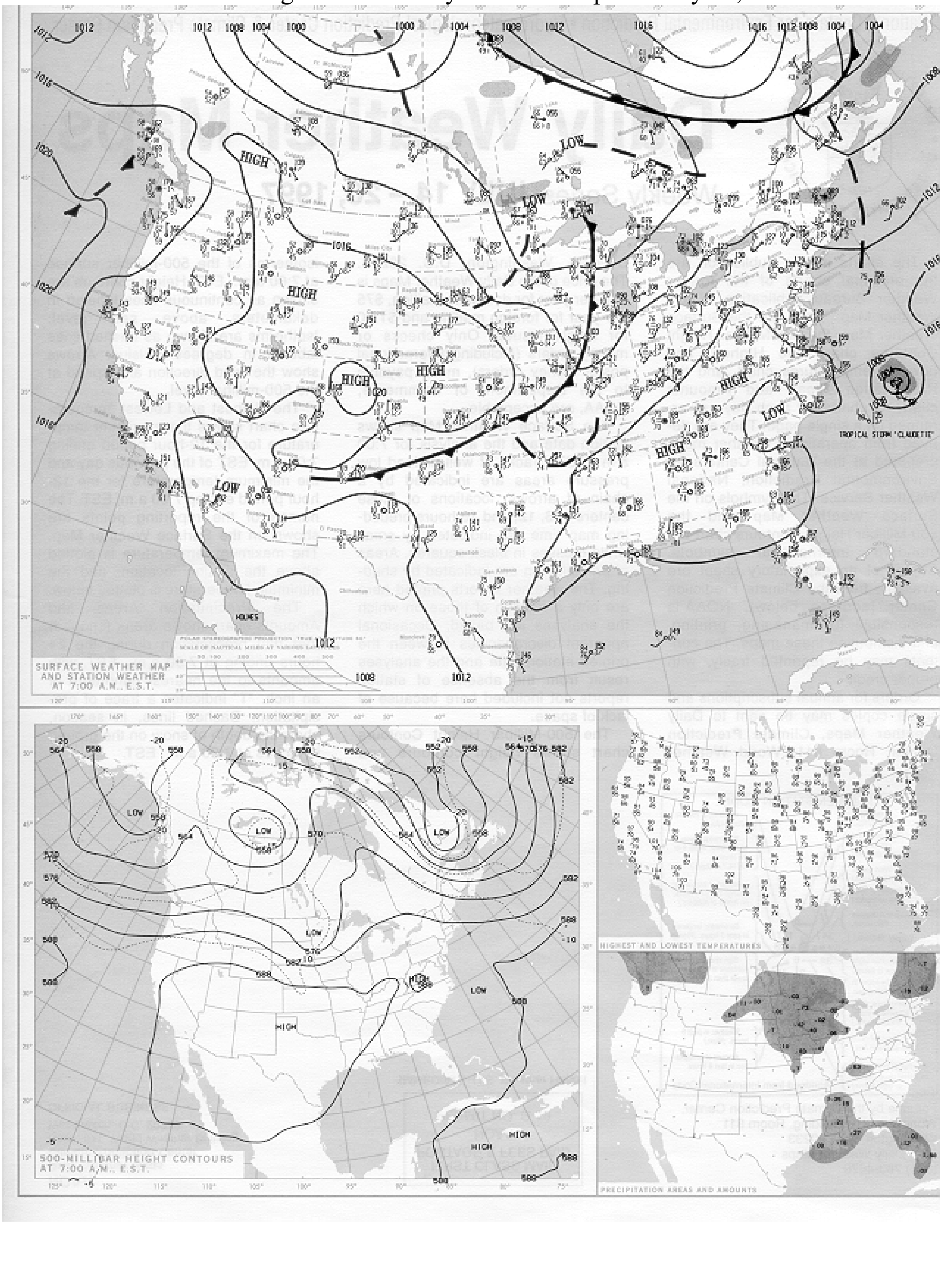


Figure 3.5-5 Backward Air Parcel Trajectories for July 14, 1997

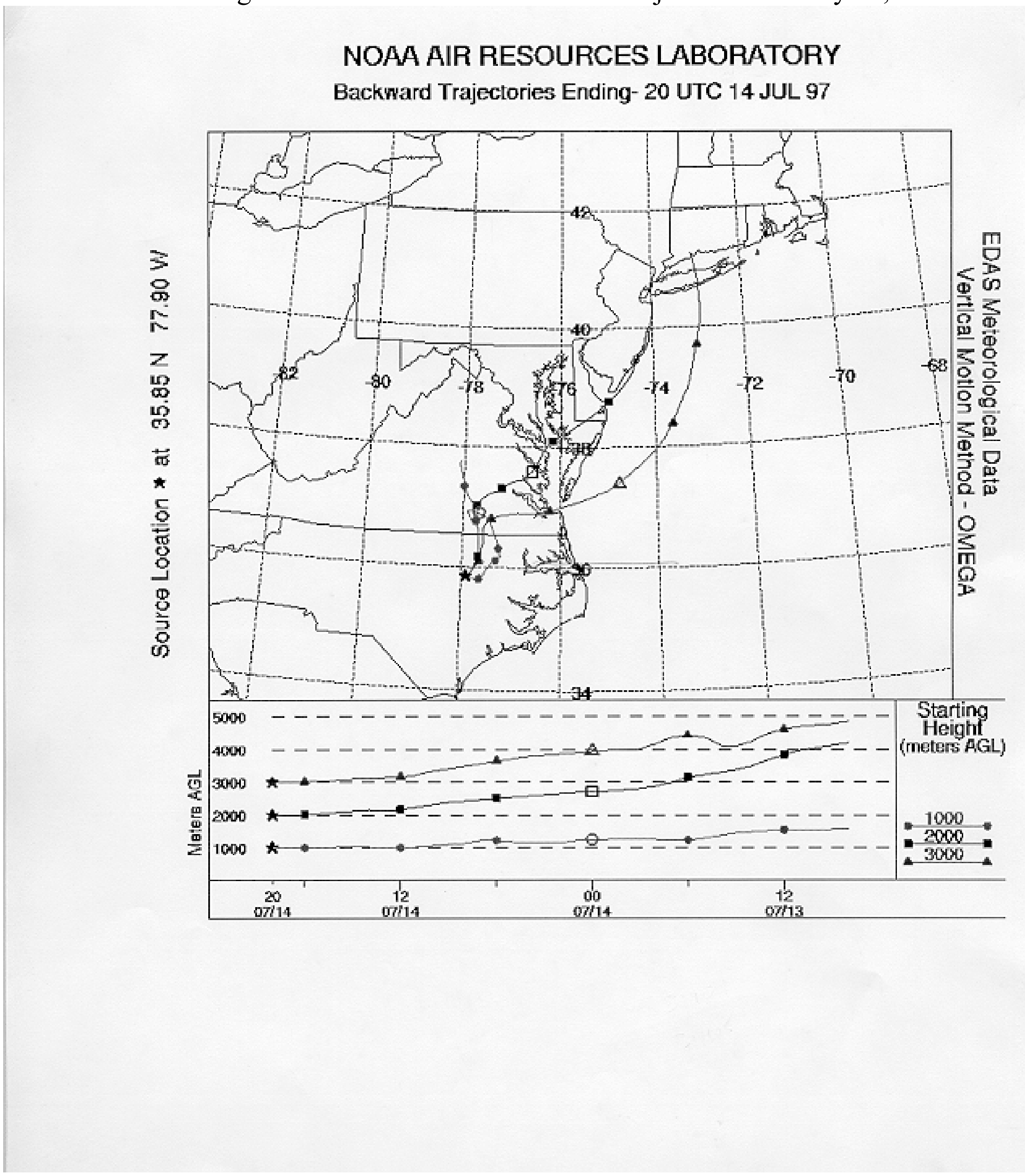


Table 3.5-1 Features of Each Selected Episode

	E1	E2	E3	E4
Synoptic Features	Large blocking upper level High over Midwest slides eastward over the large surface High over Eastern US.	Front to the north. High pressure center SW of NC. Front moves into NC, then retreats as a warm front.	Canadian surface High moves south into NC. Upper level ridge over middle of country.	Canadian surface High moves south of NC. Upper level flow weakens. Possible influence from tropical system of the coast.
Scale	Multi-regional exceedances of 1-hr & 8-hr standard.	Primarily NC.	Primarily NC.	Multi-regional exceedances of 1-hr and 8-hr standard.
Temperatures	Mid - upper 90's in NC. 90's to 100's throughout MW, NE, & South.	Low - mid 90's in NC and South. mid 80's - low 90's MW & NE.	Upper 80's in NC. Mid - upper 80's NE & MW. Low 90's in South.	Initially upper 80's, then mid-to-upper 90's for NC and Mid-Atlantic.
Dew Pt Temps	Upper 60's - low 70's in NC. As high as low 80's NE & MW.	Low 70's.	Low-to-mid 60's.	Upper 60's – low 70's in NC and Mid-Atlantic.
Local Features	North to South trough over east/central NC. Clean air east of trough effects O3 in CLT & RDU.	Front dips into northern NC & retreats as warm front creating wind shifts and re-circulation patterns.	Influence of Canadian High. Dry air & northerly winds at surface & upper levels.	Stagnating winds throughout atmosphere. Possible influence from tropical system in eastern NC.
Ozone Conc's	1-hr around 130 in GSO, CLT. 170's in Baltimore, 160's in Atlanta, 150's in MW.	Multi-day exceedances of 8-hr in 3 major areas of NC. 1-hr exceedances on 3 days in CLT.	Multi-day exceedances of 8-hr in 3 major areas of NC. 1-hr exceedances in GSO & CLT on last day.	Multi-day exceedances of 8-hr in all major NC metro areas. 1-hr exceedances on 2 days (1 RDU & 1 CLT).

4 METEOROLOGICAL MODELING

4.1 Introduction

Meteorological data needed for the MAQSIP application were obtained from the MM5 modeling system. Numerical meteorological models solve the governing equations of atmospheric physics over time and space in order to provide cell-specific meteorological inputs into the photochemical model.

Prognostic models such as MM5 are particularly advantageous (as opposed to objective/diagnostic techniques for meteorological input development) over domains in which atmospheric circulation not adequately characterized by existing data networks play an important role in pollutant transport. Within the modeling domain topographical flow, sea breeze circulation, and the effects of differential UV attenuation due to clouds will need to be accurately simulated in order to successfully model ozone formation, transport, and destruction within the airshed.

4.2 Grid Definition

Table 4.2-1 lists the specifications of each of the four MM5 nested grids. Figure 4-1 through 4-3 illustrates the MM5 domains utilized for the modeling. Grids 01 (108 km) and 02 (36 km) are more expansive than the outermost MAQSIP grid and are intended to capture the broad, synoptic scale meteorological features of the episodes. Grids 03 (12 km) and 04 (4km) encompass the corresponding fine-mesh domains within MAQSIP and are required to capture the mesoscale elements of pollutant transport within the airshed. Since the 4km-domain configuration varies with each episode, the numbers in Table 4.2-1 for D 04 represent the differing specifications, starting with the 1995 case.

Table 4.2-1. MM5 Grid Specifications

Grid	Resolution (km)	East-West Cells (#)	North-South Cells (#)	Time Step (s)
D 01	108	54	42	300
D 02	36	60	60	100
D 03	12	81	63	36
D 04	4	69, 126, 114	69, 75, 75	12

Figure 4.2-1 The 1995 MM5 Modeling Domain and Grids

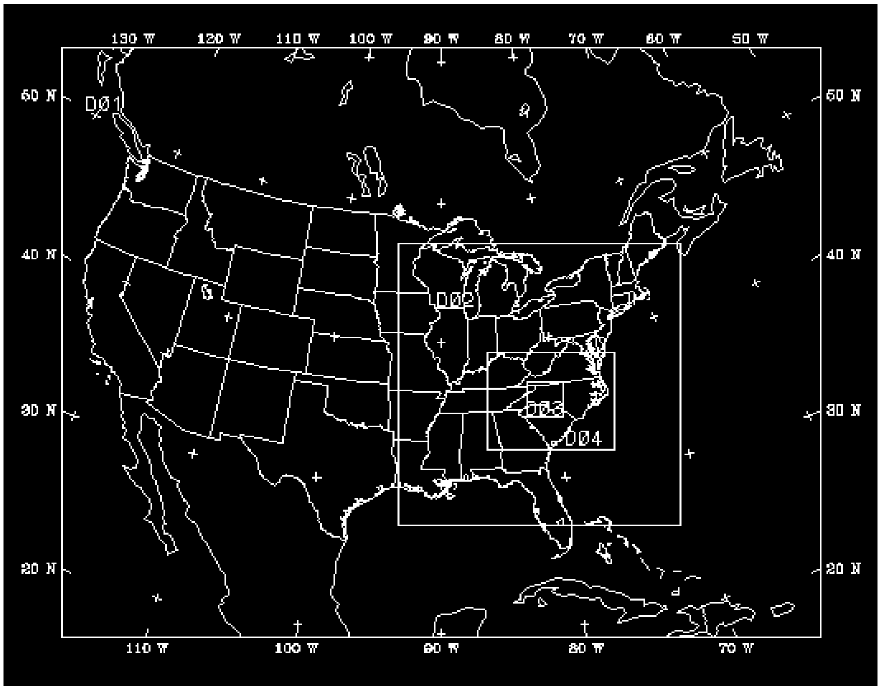


Figure 4.2-2 The 1996 MM5 Modeling Domain and Grids

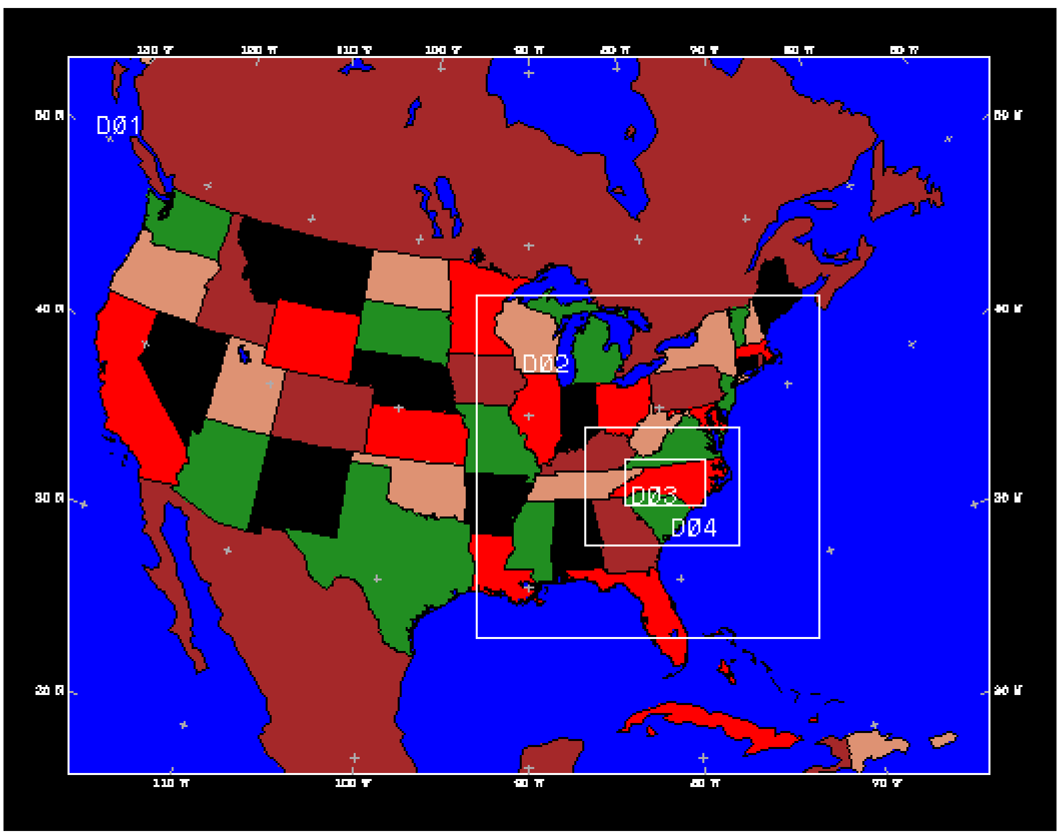
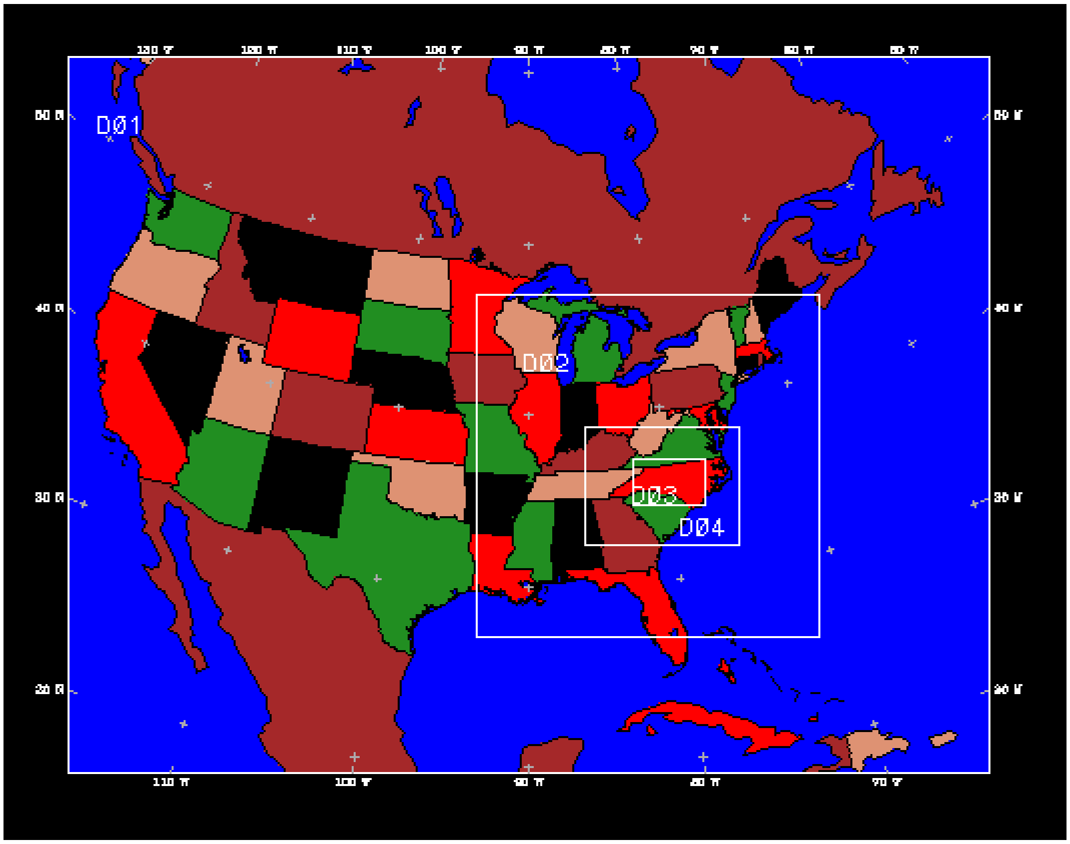


Figure 4.2-3 The 1997 MM5 Modeling Domain and Grids



Given that the emphasis of the meteorological modeling is mid-latitudinal, a Lambert Conformal map projection has been chosen. The horizontal grid uses an Arakawa-Lamb B-staggering of the wind vector components; scalar variables are defined at cell centers. In the vertical, 26 layers are modeled using terrain following coordinates (sigma coordinates). With the exception of vertical velocity, all state variables are defined at half-sigma levels (i.e., the midpoint of layer depth). The pressure at the top of the model is 100 millibars.

Table 4.2-2 shows an estimated vertical grid resolution for the meteorological model assuming standard atmosphere.

Table 4.2-2. Vertical Grid Resolution for the Meteorological Model (MM5)

Level		Pressure (mb)	Height (m)	Thickness (m)
0	1.000	1000.0	**0.0**	0.0
1	0.995	995.5	**38.0**	38.0
2	0.987	988.3	**99.2**	61.1
3	0.974	976.6	**199.3**	100.1
4	0.956	960.4	**339.5**	140.2
5	0.936	942.4	**497.5**	158.1
6	0.913	921.7	**682.4**	184.8
7	0.887	898.3	**895.4**	213.0
8	0.857	871.3	**1146.8**	251.4
9	0.824	841.6	**1430.8**	284.0
10	0.790	811.0	**1732.0**	301.2
11	0.750	775.0	**2098.3**	366.3
12	0.700	730.0	**2576.1**	477.8
13	0.650	685.0	**3078.3**	502.2
14	0.600	640.0	**3607.9**	529.6
15	0.550	595.0	**4168.6**	560.7
16	0.500	550.0	**4764.7**	596.1
17	0.450	505.0	**5401.6**	636.9
18	0.400	460.0	**6086.2**	684.6
19	0.350	415.0	**6827.3**	741.0
20	0.300	370.0	**7636.3**	809.1
21	0.250	325.0	**8529.1**	892.8
22	0.200	280.0	**9528.0**	998.8
23	0.150	235.0	**10665.7**	1137.7
24	0.100	190.0	**12021.8**	1356.1
25	0.050	145.0	**13742.3**	1720.5
26	0.000	100.0	**16094.8**	2352.5

The meteorological model used for the 1995 modeling episode, MM5 version1, used the post-processor Meteorology Chemistry Interface Processor (MCIP) to prepare the MAQSIP model inputs. This post-processor could collapse some of the meteorological layers so that the MAQSIP model could run with fewer layers and reduce the processing time. North Carolina ran a number of sensitivity runs, collapsing some of the upper layers, to see if the air quality predictions were adversely affected. From this analysis, it was determined that the minimum number of layer that the MAQSIP model could run with was 16 layers without differing significantly from running the model with all 26 layers. The first 12 layers of the meteorological model are mapped directly and the upper 14 MM5 layers are collapsed into 4 MAQSIP layers. The estimated vertical grid resolution for the MAQSIP model for the 1995 modeling episode is shown in Table 4.2-3.

Table 4.2-3. Vertical Grid Resolution for MAQSIP for the 1995 Episode

Level	Height (m)	Thickness (m)
0	**0.0**	0.0
1	**38.0**	38.0
2	**99.2**	61.1
3	**199.3**	100.1
4	**339.5**	140.2
5	**497.5**	158.1
6	**682.4**	184.8
7	**895.4**	213.0
8	**1146.8**	251.4
9	**1430.8**	284.0
10	**1732.0**	301.2
11	**2098.3**	366.3
12	**2576.1**	477.8
13	**4168.6**	1592.5
14	**6827.3**	2658.7
15	**10665.7**	3838.4
16	**16094.8**	5429.1

For the 1996 and 1997 modeling episodes, newer versions of the meteorological model were used. The post-processor for the new versions is Meteorology-Coupler (MCPL) and it cannot collapse the meteorological data into a format that the MAQSIP model can use. Therefore, the photochemical model runs with 26 layers, mapping the meteorological data directly, for the 1996 and 1997 episodes.

4.3 MM5 Physics Options

One-way nested grids
Non-hydrostatic dynamics
Four-dimensional data assimilation (FDDA):

- analysis nudging of wind, temperature, and mixing ratios every 12 hours
- nudging coefficients range from $1.0 * 10^{-5}$ s^{-1} to $3.0 * 10^{-4}$ s^{-1}
- No initial FDDA for 12 km and 4 km grids

Explicit moisture treatment:

- 3-D predictions of cloud and precipitation fields
- simple ice microphysics
- cloud effects on surface radiation
- moist vertical diffusion in clouds
- normal evaporative cooling

Boundary conditions:

- relaxation inflow/outflow (Grid 01)
- time-dependent (Grids 02, 03, & 04)

- rigid upper boundary

Cumulus cloud parameterization schemes:

- Anthes-Kuo (Grid 01)
- Kain-Fritsch (Grids 02 and 03) 1995 & 1996 episodes, Grell (Grids 02 and 03) 1997
- no cumulus parameterization (Grid 04)

Full 3-dimensional Coriolis force
Drag coefficients vary with stability
Vertical mixing of momentum in mixed layer
Virtual temperature effects
Planetary boundary layer process parameterization:

- Modified Blackadar scheme (Grids 02, 03 and 04) for 1996 and 1997 episodes and Grid 02 for 1995 episode; Gayno-Seaman scheme (Grids 03 and 04) for 1995 episode.

Surface layer parameterization:

- fluxes of momentum, sensible and latent heat
  - ground temperature prediction using energy balance equation
  - 13 land use categories

Atmospheric radiation schemes:

- Simple cooling
- Long- and short-wave radiation scheme

Several application specific modifications:

- m5_dry.mods -- lowers MM5 soil moisture when appropriate locally
- mavail_adj.mods -- changes soil moisture as a function of soil type as needed
- m5_flyer.mods -- modifications to optimize on NCSC CRAY T-90
- kfbm_edss.mods -- writes special Kain-Fritsch meteorological data
- m5_height.mods -- calculates MM5 layer heights correctly for non hydrostatic
- m5_epafiles.mods -- writes additional data out to air quality model
- m5_blkdr_hts.mods -- modifies PBL height calculations to a VMM scheme

4.4 Inputs

Table 4.4-1 describes the terrain and land use fields input into MM5 for the modeling.

Table 4.4-1 Terrain and Land Use Inputs to MM5

Grid	Terrain origin	Terrain resolution	Land use origin	Land use resolution
G 01	PSU/NCAR	30 minute	PSU/NCAR	30 minute
G 02	GDC	10 minute	PSU/NCAR	10 minute
G 03*	GDC	5 minute	PSU/NCAR	5 minute
G 04*	GDC	5 minute	PSU/NCAR	5 minute

*Land use data were slightly modified in the Charlotte area to minimize the number of cells characterized as urban. Also, several cells along the NC/SC coastline were modified to reflect mixed forest - wetland as opposed to water.

The TOGA (2.5 by 2.5 degrees) data set was used to provide a first-guess interpolation of meteorological data to the horizontal modeling grid. Climatological averages of sea-surface temperature were used to characterize ocean temperatures. Three- and six-hourly NWS data (first-order) were used to develop the surface analysis fields. Standard twice-daily rawinsonde data from the NWS were used in the preparation of aloft FDDA analysis fields.

4.5 Performance Evaluation

The standard set of objective metrics to evaluate model performance for various meteorological parameters were generated for this project. The basic methodology employed used the base variables that were available for observational nudging. These variables include temperature, water vapor mixing ratio, east-west wind and south-north wind. Note that only the wind components are actually used for observational nudging. The observed winds have been rotated to the model projection (Lambert Conformal). The model/obs pairs are matched on a grid cell basis; no bilinear interpolation is performed. If more than one observation lies within a cell, the observations are averaged and the value is treated as if it were a single observation. For the wind components and mixing ratio, layer 1 (~38m) values are used. Temperatures are adjusted to 1.5 meters by logarithmically interpolating between the layer 1 temperature and the "skin" temperature. The results of this interpolation were compared with a more sophisticated methodology in which the interpolation varies with stability class, and we found little significant differences between the two. Since observational nudging was employed only at 12-km and 4-km resolutions, performance statistics were produced only for those grids.

A limited sample of the performance metrics for each episode is provided in Figures 4.5-1 through 4.5-7 below. For an exhaustive review of the meteorological modeling results, please visit: http://www.emc.mcnc.org/projects/NCDAQ/PGM/results/index.htm

Figure 4.5-1 Temperature performance metric – 1995 episode - 4km domain

Figure 4.5-2 Example Temperature Metric - 1995 episode - 12 km domain

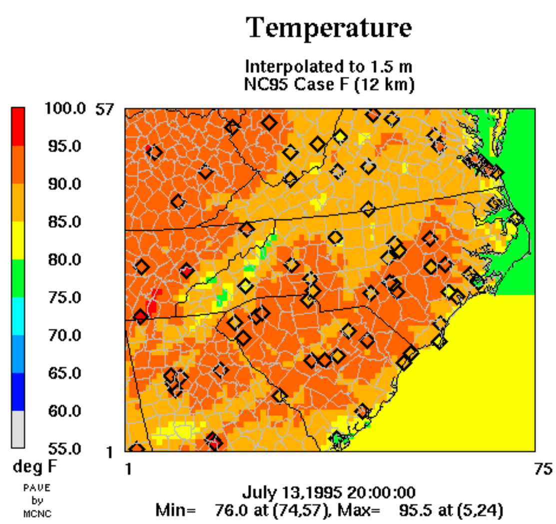


Figure 4.5-3 Temperature performance metric – 1996 episode - 4km domain

Figure 4.5-4 Example Temperature Metric - 1996 episode - 12 km domain

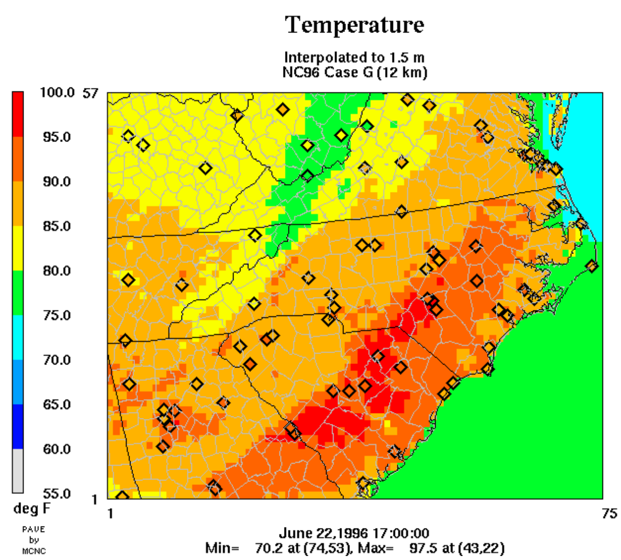
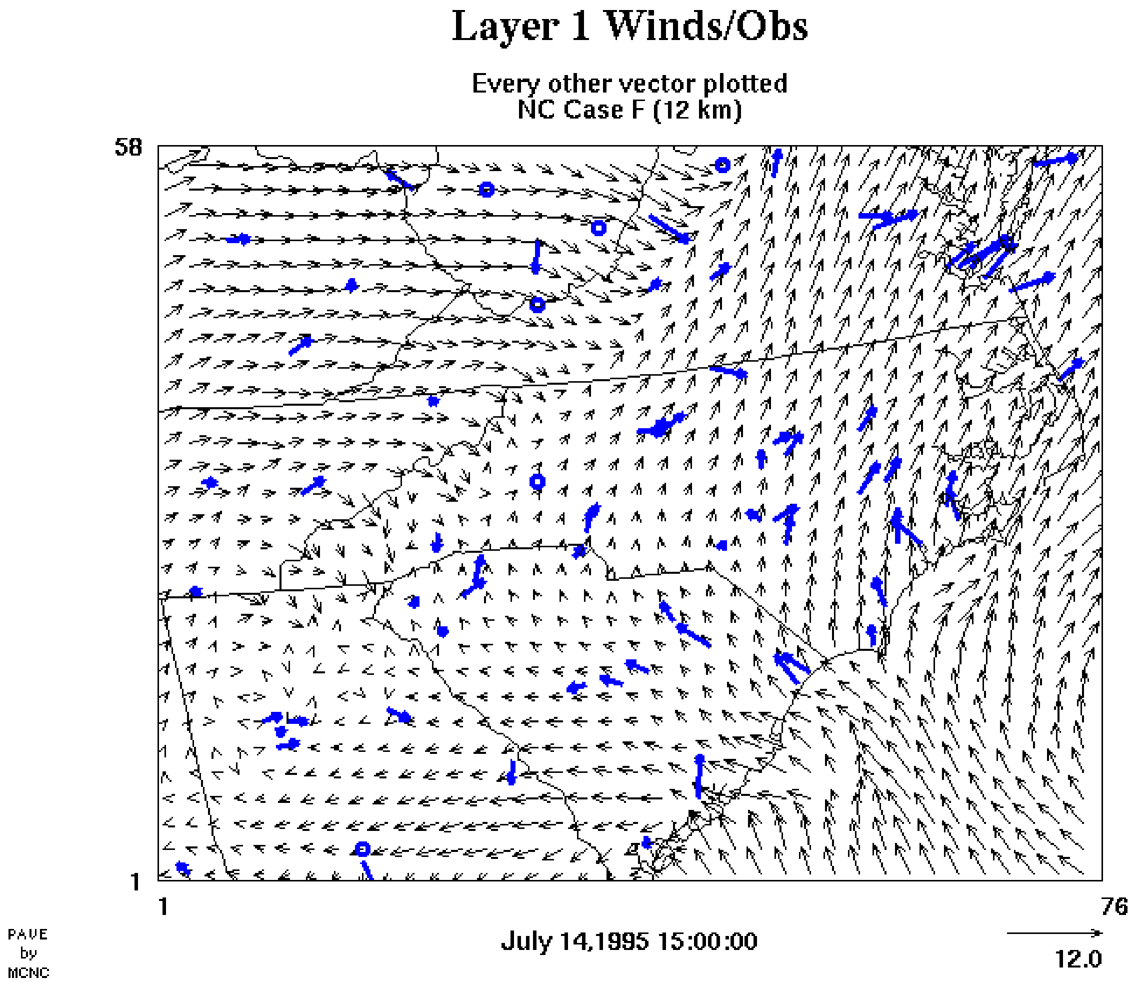


Figure 4.5-5 Temperature performance metric – 1996 episode - 4km domain

Figure 4.5-6 Example Temperature Metric - 1997 episode - 12 km domain

Figure 4.5-7 Example Layer 1 Wind Vector Metric - 1995 episode - 12 km domain
Blue vectors=observations, black vectors=model



Currently, there is no accepted standard by which to judge meteorological model performance. Modelers usually calculate the basic statistics such as bias, error, or index of agreement and compare their results with the same quantities from prior and similar modeling exercises. The problem with such an approach is that these numbers are a function of the domain size modeled, the length of the simulation, and the meteorology being modeled. In this modeling study, the modeling team, including a number of air quality meteorologists, examined all of the meteorological modeling output both quantitatively through statistical metrics and qualitatively through a series of graphical metrics.

When passing final judgment regarding the accuracy of a meteorological simulation, the modeling team concluded that the results satisfactorily address the following questions:

A. *Do the model results fit our conceptual understanding?* The model replicates the observed synoptic pattern, placing surface pressure systems in the proper location and matches the upper air pattern.

B. *Are diurnal features adequately captured?* The diurnal cycle is adequately represented in the model. For example, the mixing heights increase during the day and collapse at night in a reasonable way. Similarly temperatures, summertime convection, and winds show diurnal variation.

C. Is the vertical mixing appropriate? The PBL depth and evolution is well modeled.

D. *Are clouds reasonably well modeled?* Secondary quantities such as clouds are particularly useful to analyze since they are not "nudged" to the observations. We see that on a synoptic scale the model clouds will generally match the observations. Convective clouds are unlikely to occur precisely in the right place and at the right time, but the general region/time of convective development is adequate.

E. Do the wind fields agree with the observations? The model adequately captures the observed wind fields so that transport in the subsequent air quality runs is done correctly.

G. Do the temperature and moisture fields generally match the observations? These first order scalar quantities are well captured by the model.

H. Do the meteorological fields produce acceptable air quality results? While air quality models can have problems of their own, many times poor air quality modeling results occur due to problems with the input meteorological fields. This is often a good test to determine whether the meteorological model adequately predicts the fields to which the air quality model is most sensitive. A number of air quality runs were conducted to test the sensitivity to different meteorological inputs.

5 EMISSIONS INVENTORY

5.1 Introduction

There are five different emission inventory source classifications, stationary point and area sources, off-road and on-road mobile sources, and biogenic sources.

Stationary point sources are those sources that emit greater than a specified tonage per year and the data is provided at the facility level. Stationary area sources are those sources whose emissions are relatively small but due to the large number of these sources, the collective emissions could be significant (i.e., dry cleaners, service stations, etc.) These type of emissions are estimated on the county level. Off-road mobile sources are equipment that can move but do not use the roadways, i.e., lawn mowers, construction equipment, railroad locomotives, aircraft, etc. The emissions from these sources, like stationary area sources, are estimated on the county level. On-road mobile sources are automobiles, trucks, and motorcycles that use the roadway system. The emissions from these sources are estimated by vehicle type and road type and are summed to the county level. Biogenic sources are the natural sources like trees, crops, grasses and natural decay of plants. The emissions from these sources are estimated on a county level.

In addition to the various source classifications, there are also various types of emission inventories. The first is the base year or episodic inventory. This inventory is based on the year of the episode being modeled and is used for validating the photochemical model performance.

The second inventory used in this project is the "current" year inventory. For this modeling project it will be the 2000 emission inventory, which is the most current. This inventory is processed using all of the different meteorological episodes being studied. The photochemical modeling is processed using the current year inventory and those results are used as a representation of current air quality conditions.

Next is the future year base inventory. For this type, an inventory is developed for some future year for which attainment of the ozone standard is needed. For this modeling project the future years will be 2007 and 2012. It is the future year base inventories that control strategies and sensitivities are applied to determine what controls, to which source classifications, must be made in order to attain the ozone standard.

In the sections that follow, the base year inventories used for each source classifications are discussed. Emission summaries by county for the entire State are in Appendix A.

5.2 Stationary Point Sources

Point source emissions are emissions from individual sources having a fixed location. Generally, these sources must have permits to operate and their emissions are inventoried on a regular schedule. Large sources having emissions of 100 tons per year (tpy) of a criteria pollutant, 10 tpy of a single hazardous air pollutant (HAP), or 25 tpy total HAP are inventoried annually. Smaller sources have been inventoried less frequently. The point source emissions data can be grouped into the large electric utility sources and the other point sources.

5.2.1 Large Utility Sources

The inventory used for the large utility sources is the May 1999 release of the NOx SIP call base year modeling foundation files obtained from the USEPA Office of Air Quality Planning and Standards (OAQPS). The base year for this utility data is 1996. This data is provided in EMS 95 format. The emissions data for the utilities is episode specific CEM data and is specific for each source for each hour of the modeling episode. This data comes from the USEPA Acid Rain Division (ARD). Since only NOx emissions are measured, the CO and VOC emissions are calculated from the NOx emissions using emission factor ratios (CO/NOx and VOC/NOx) for the particular combustion processes at the utilities.

5.2.2 Other Point Sources

The inventory used to model the other point sources is the May 1999 release of the NOx SIP call base year modeling foundation files obtained from the USEPA OAQPS. This data is based on 1995 emissions and is provided in EMS 95 format. For the 1996 and 1997 modeling episode, emissions were grown using Bureau of Economic Analysis (BEA) growth factors. The North Carolina sources were an exception. These emissions are true 1996 emissions for the larger VOC and NOx sources. In addition, emissions for forest fires and prescribed burns are treated as point sources and are episode specific similar to CEM data.

The emissions summary for the 1996 episodes for the Fayetteville EAC area is listed in Table 5.2-1. These emissions represent a typical weekday, Thursday's (June 20th), emissions and are in tons per day. In some instances a county may not have had emissions for the 20th but did have emissions during the modeling episode due to forest fires or prescribed burns that were treated as point sources.

Table 5.2-1 Stationary Point Source Emissions

County	CO	NOX	VOC
Cumberland	0.412	2.956	7.072

5.3 Stationary Area Sources

The base year inventory for the stationary area sources is the May 1999 release of the NOx SIP call base year modeling foundation files obtained from the USEPA OAQPS. This data is based on 1995 and is provided in EMS 95 format. For the 1996 and 1997 base years, the NOx SIP call foundation files will be grown to the respective year by use of Bureau of Economic Analysis (BEA) growth factors or projected population growth obtained from the US Census Bureau.

The exception to this is for North Carolina where a 2000 base year inventory was generated by NCDAQ following the current methodologies outlined in the Emissions Inventory Improvement Program (EIIP) Area Source Development Documents, Volume III (http://www.epa.gov/ttn/chief/eiip/techreport/volume03/index.html). This data was backcasted to the base years via growth factors developed with EPA's Economic Growth Analysis System (EGAS) version 4.0.

The emissions summary for the 1996 episodes for the Fayetteville EAC area is listed in Table 5.3-1. These emissions represent a typical weekday, Thursday's (June 20th), emissions and are in tons per day.

Table 5.3-1 Stationary Area Source Emissions

County	NOx	VOC	CO
Cumberland	3.34	22.74	15.31

5.4 Off-Road Mobile Sources

The off-road mobile sources can be broken down into two types of sources; those calculated within the USEPA NONROAD mobile model and those that are not. For the sources that are calculated within the NONROAD mobile model, a base year inventory was generated for the entire domain for each of the base years. The model version used is the Draft NONROAD2002 distributed for a limited, confidential, and secure review in November 2002. If the final version or any newer draft versions of this model is released by the USEPA, an assessment of the difference in the emission estimations will be made to determine if a new inventory must be generated and processed through the photochemical model.

The sources not calculated within the NONROAD model include aircraft engines, railroad locomotives and commercial marine vessels. The base year inventory for these sources was the May 1999 release of the NOx SIP call base year modeling foundation files obtained from the USEPA OAQPS. This data is based on 1995 and is provided in EMS 95 format. For the 1996 and 1997 base years, the NOx SIP call foundation files were grown to the respective year by use of Bureau of Economic Analysis (BEA) growth factors.

The exception to this was for North Carolina where a 1995 base year inventory was generated by NCDAQ for aircraft engines and railroad locomotives. This data was then grown to the other base years via BEA growth factors or other State specific data.

The emissions summary for the 1996 episodes for the Fayetteville EAC area is listed in Table 5.4-1. These emissions represent a typical weekday, Thursday's (June 20th), emissions and are in tons per day.

Table 5.4-1 Off-Road Mobile Source Emissions

County	NOx	VOC	CO
Cumberland	2.73	11.73	64.64

5.5 Highway Mobile Sources

In order to accurately model the mobile source emissions in the EAC areas, the newest version of the MOBILE model, MOBILE6.2, was used. This model was released by EPA in 2002 and differs significantly from previous versions of the model. Key inputs for MOBILE include information on the age of vehicles on the roads, the speed of those vehicles, what types of road those vehicles are traveling on, any control technologies in place in an area to reduce emissions for motor vehicles (e.g., emissions inspection programs), and temperature. Baseline estimates were created for the episode June 19 – July 1, 1996.

5.5.1 Speed Assumptions

Emissions from motor vehicles vary with the manner in which the vehicle is operated. Vehicles traveling at 65 mph emit a very different mix of pollutants than the car that is idling at a stoplight. In order to estimate emissions from vehicles for a typical day, North Carolina Department of Transportation (NCDOT) provided speeds for each of the urban areas across the state and in some cases for different times of the day. To reflect the most current assumptions on the speed of vehicles in different areas across the state, the latest conformity report was used which reflected speeds developed through travel demand modeling for the urban areas. Separate speed profiles were created for Wake County (covering Durham and Orange Counties) Greensboro, Winston-Salem, Mecklenburg County (covering Gaston County), and "rest of state". In Wake, Durham, Orange, Mecklenburg and Gaston Counties, a profile was created based on a morning traffic peak, an afternoon traffic peak, and an offpeak for the remainder of the day. In Wake, Durham, and Orange Counties the morning peak covered the period from 6 am – 10 am, and the afternoon peak from 4 pm – 8 pm. In Mecklenburg and Gaston Counties the morning peak covered the period from 6 am – 9 am, and the afternoon peak covered the period from 4 pm – 7 pm. These assumptions were provided by the Metropolitan Planning Organizations (MPOs) in each of the areas. For the rest of the state, NCDAQ chose to use the Wake County speed profile developed in 1998. This was assumed to be a conservative estimate of speeds in areas that do not have a travel demand model.

Table 5.5-1 provides a summary of the speeds used in this episode run.

Table 5.5-1: 1996 Speed Assumptions for Mobil Model

Wake, Durham, Orange Counties (based on 1995 speeds)			
Road Type	**Morning Peak**	**Afternoon Peak**	**Offpeak**
Urban Interstate	55	55	55
Urban Freeway	48	47	54
Urban Other P. Art	38	39	44
Urban Minor Art	40	40	43

Wake, Durham, Orange Counties (based on 1995 speeds)			
Road Type	**Morning Peak**	**Afternoon Peak**	**Offpeak**
Urban Collector	36	36	36
Urban Local	36	36	37
Rural Interstate	56	59	64
Rural Other P. Art	53	52	57
Rural Minor Art	48	47	50
Rural Major Coll	46	46	46
Rural Minor Coll	43	43	43
Rural Local	44	44	44

Greenboro (based on 1994 speeds)	
Road Type	**Speed**
Urban Interstate	41
Urban Freeway	46
Urban Other P. Art	27
Urban Minor Art	30
Urban Collector	31
Urban Local	33
Rural Interstate	56
Rural Other P. Art	53
Rural Minor Art	41
Rural Major Coll	44
Rural Minor Coll	44
Rural Local	44

Winston-Salem (based on 1994 speeds)	
Road Type	**Speed**
Urban Interstate	55
Urban Freeway	48
Urban Other P. Art	29
Urban Minor Art	22
Urban Collector	29

Winston-Salem (based on 1994 speeds)	
Urban Local	24
Rural Interstate	55
Rural Other P. Art	55
Rural Minor Art	44
Rural Major Coll	41
Rural Minor Coll	39
Rural Local	26

Mecklenburg and Gaston			
Road Type	**Morning Peak**	**Afternoon Peak**	**Offpeak**
Urban Interstate	55	55	55
Urban Freeway	48	47	54
Urban Other P. Art	38	39	44
Urban Minor Art	40	40	43
Urban Collector	36	36	36
Urban Local	36	36	37
Rural Interstate	56	59	64
Rural Other P. Art	53	52	57
Rural Minor Art	48	47	50
Rural Major Coll	46	46	46
Rural Minor Coll	43	43	43
Rural Local	44	44	44

Rest of State			
Road Type	**Morning Peak**	**Afternoon Peak**	**Offpeak**
Urban Interstate	60	61	63
Urban Freeway	55	59	61
Urban Other P. Art	34	35	32
Urban Minor Art	34	35	34
Urban Collector	35	34	33
Urban Local	30	37	37
Rural Interstate	49	62	67
Rural Other P. Art	38	41	42

Rest of State			
Road Type	Morning Peak	Afternoon Peak	Offpeak
Rural Minor Art	49	50	53
Rural Major Coll	32	46	46
Rural Minor Coll	33	41	44
Rural Local	42	45	42

5.5.2 Vehicle Age Distribution

The vehicle age distribution comes from annual registration data from the NCDOT. NCDOT has provided registration data specific to the area. For this analysis, the data was from 2000. NCDOT provides the data by vehicle type; however, these types do not match the EPA MOBILE types. Therefore, the data is manipulated to match the input requirements as follows:

- NCDOT provides at least 25 years for all vehicle types, however MOBILE5 only recognizes 12 years for motorcycles. Therefore, the first 13 years are combined into one number.
- If more than 25 years are provided, the early years are combined and included in the 25^{th} model year.
- NCDOT does record model years beyond the year of the report, for this set of data, 2001 model year was added to the 2000 model year information.
- The same registration distribution by age must be entered for Light Duty Gasoline Vehicles (LDGV), Light Duty Diesel Vehicles (LDDV), and for Light Duty Gasoline Trucks 1 and 2 (LDGT1 and LDGT2) according to the MOBILE5 User's Guide.

Then using the MOBILE6.2 utility provided by EPA the vehicle types were distributed across the 16 types in MOBILE6.2. A separate age distribution was created for each of the urban areas and for the rest of the state (see Appendix B).

5.5.3 Vehicle Mix Assumptions

For all of North Carolina, vehicle mix has incorporated the increase in sales of sport utility vehicles and minivans for all years of evaluation.

To calculate the vehicle mix to account for the large percentage of sport utility vehicles and minivans being purchased, NCDAQ used the following documentation from EPA: Fleet Characterization Data for MOBILE6: Development and Use of Age Distributions, Average Annual Mileage Accumulation Rates, and Projected Vehicle Counts for Use in MOBILE6 (EPA420-P-99-011). This document includes a breakdown by year from 1983 to 2050 of the number of light duty vehicles (according to MOBILE6 five vehicle types) on the roads on a national basis. NCDAQ used this data and combined vehicle types to reflect the three

MOBILE5 light duty vehicle types. These calculated values for LDGT1 and LDGT2 are used for all road types. No changes were made to this file for this modeling effort because of the way in which the SMOKE model has incorporated MOBILE6.2. Table 5.5-2 provides the vehicle mix for North Carolina.

Table 5.5-2: 1996 North Carolina Vehicle Mix

Rural	LDGV	LDGT1	LDGT2	HDGV	LDDV	LDDT	HDDV	MC
Interstate(-0.001)	0.458	0.174	0.062	0.031	0.002	0.002	0.266	0.005
Oth Prin Art(+0.001)	0.557	0.211	0.075	0.04	0.002	0.002	0.109	0.004
Minor Ar(-0.001)	0.571	0.219	0.078	0.045	0.003	0.003	0.076	0.005
Major Col (+0.001)	0.591	0.225	0.08	0.044	0.002	0.002	0.052	0.004
Minor Col	0.591	0.225	0.08	0.042	0.002	0.002	0.053	0.005
local	0.589	0.227	0.081	0.049	0.003	0.003	0.042	0.006

Urban	LDGV	LDGT1	LDGT2	HDGV	LDDV	LDDT	HDDV	MC
Interstate (-0.002)	0.534	0.201	0.072	0.033	0.002	0.002	0.152	0.004
Oth Freeway	0.583	0.218	0.078	0.035	0.002	0.002	0.079	0.003
Oth Prin Art(+0.001)	0.6	0.224	0.08	0.036	0.002	0.002	0.053	0.003
Minor Art(-0.001)	0.614	0.229	0.082	0.035	0.002	0.002	0.032	0.004
Collectors(-0.001)	0.622	0.231	0.082	0.033	0.002	0.002	0.025	0.003
local (+0.001)	0.602	0.228	0.081	0.041	0.002	0.002	0.038	0.006

HDGV – Heavy Duty Gasoline Vehicles, LDDT – Light Duty Diesel Trucks, HDDV – Heavy Duty Diesel Vehicles, MC - Motorcycles

5.5.4 Temperature Assumptions

Temperatures are extracted from the MM5 meteorological model files.

5.5.5 Vehicle Inspection and Maintenance Program Assumptions

In the early 1990's, North Carolina adopted emissions inspection requirements for vehicles in 9 urban counties. This program tests emissions at idle for 1975 and newer gasoline powered light duty vehicles. The program is a basic, decentralized tailpipe test for Hydrocarbon (HC) and CO only. The waiver rates are consistent with the SIP. However, the compliance rates have been changed to more accurately reflect what is happening at the stations. Compliance rates have been changed from 98 percent in the SIP to 95 percent. In addition, the inspection stations are required to administer an anti-tampering check to ensure that emissions control equipment on any vehicle 1968 and newer has not been altered.

5.5.6 RVP Assumptions

Reid vapor pressure (RVP) reflects a gasoline's volatility, so as a control measure North Carolina has adopted the Phase II RVP of 7.8 psi in the 1-hour ozone maintenance counties.

The emissions summary for the 1996 episodes for the Fayetteville EAC area is listed in Table 5.5-4. These emissions represent a typical weekday, Thursday's (June 20th), are in tons per day.

Table 5.5-4 Highway Mobile Emissions

County	CO	NOx	VOC
Cumberland	223.26	30.32	20.98

5.6 Biogenic Emission Sources

Biogenic emissions will be prepared with the SMOKE-BEIS3 (Biogenic Emission Inventory System version3) preprocessor. SMOKE-BEIS3 is basically the Urban Airshed Model (UAM)-BEIS3 model but also includes modifications to use Meteorological Model version 5 (MM5) data, gridded land use data, and one important science update. The emission factors that are used in SMOKE-BEIS3 are the same as the emission factors in UAM-BEIS3.

The emission rates within SMOKE-BEIS3 are adjusted for environmental conditions prevailing during the episode days with meteorological data supplied by the MM5 model. The gridded data used from MM5 include the estimated temperature at 10 meters above the surface and short-wave radiation reaching the surface. Ten meters temperatures will be used instead of the ground temperatures because it is believed that 10 meters above the surface is a good approximation of the average canopy height. The use of 10 meters temperatures was discussed with and approved by the USEPA Office of Research and Development (ORD).

The gridded land use data has been obtained from Alpine Geophysics at the 4-km resolution for the entire domain. The basis for the gridded data is the county land use data in the Biogenic Emissions Landcover Database version 3 (BELD3) provided by the USEPA. A separate land classification scheme, based upon satellite (AVHRR, 1 km spatial resolution) and census information, aided in defining the forest, agriculture and urban portions of each county. The 12-km and 36-km domains will be created by aggregating the 4-km resolution data up to the respective grid sizes.

The emissions summary for the 1996 episodes for the Fayetteville EAC area is listed in Table 5.6-1. These emissions represent a normalized emission and are in tons per day.

Table 5.6-1 Biogenic Emissions

County	NOx	VOC
Cumberland	1.0	134.7

6 MODELING STATUS

6.1 Status of Current Modeling

NCDAQ realized that the May 31, 2003 date for completing the base case model evaluation was not realistic due to the issues described in Section 6.2 below. Sheila Holman sent a letter to Kay Prince requesting an adjustment to the modeling schedule due to these issues. Ms. Holman's letter and Ms. Prince's response are included in Appendix C. NCDAQ continues to believe that completing the four 2007 base year modeling runs is achievable by August 29, 2003.

6.2 Issues Being Encountered

There have been a number of issues encountered during this modeling effort. The first was the integration of MOBILE6.2 into SMOKE. It is a requirement of the EAC that MOBILE6.2 be used to estimate the mobile emissions and if transportation conformity is ever needed in the EAC areas, it will be based on the emission estimates from this modeling effort. It took much longer than anticipated to get the integration completed.

Another issue was porting SMOKEv1.5 to the NCDAQ HP UNIX workstation. Compiling on the HP was not very straight forward and actually turned up some errors in the SMOKEv1.5 code. It took several weeks before the code was completely compiled and tested on the HP workstation and was ready for the NCDAQ emissions staff to use.

The next issue encountered dealt with the installation and use of MIMS. MIMS is a gui interface that aids the user in choosing the files that will be used in SMOKE to process the emissions. Since most of the NCDAQ emissions staff is not very familiar with the UNIX environment, it was believed that the MIMS interface would aid in processing the emissions. NCDAQ was never able to get MIMS to work on their system and therefore had to use scripts to process the emissions.

Another issue was the discovery of errors in the mobile and point source emissions during the quality assurance (QA) of the emissions data. For the mobile inventory, VMT was inadvertently left off for two of the urban counties, Guilford and Forsyth Counties. For the point source inventory, it was discovered that stack data for some of the utilities did not read in correctly and default stack parameters were used. This would result in the emissions being dumped into the lower layer of the model. These errors resulted in the emissions having to be reprocessed through SMOKE and re-merged with the other data.

6.3 Geographic Area Needing Further Controls

At this point in the project, NCDAQ is unable to identify the geographic area that will need controls beyond what is already in North Carolina's rules. The controls that will be included in the base 2007 emissions inventory are the NOx SIP Call, a NOx Inspection and Maintenance (I/M) program that will cover 48 counties in North Carolina and the North Carolina Clean Smokestacks Act that requires year-round controls on the major utilities in North Carolina.

By the December 2003 Progress Report, NCDAQ should be able to provide modeling results that show where additional controls are needed over what geographic area.

6.4 Anticipated Resource Constraints

The resource constraint of most concern is the funding needed to implement some of the local control measures. NCDAQ and the local EAC areas are both looking for grant opportunities to help fund EAC initiatives.

7 APPENDIX A

Stationary Point Sources Emissions

County	CO	NOx	VOC
Alamance Co	0.061	0.676	0.960
Alexander Co	0.014	0.004	2.099
Ashe Co	0.030	0.006	1.289
Beaufort Co	1.162	1.969	0.859
Bertie Co	0.162	0.227	1.101
Bladen Co	0.181	1.857	0.520
Brunswick Co	3.758	7.786	3.453
Buncombe Co	1.336	57.016	3.135
Burke Co	5.753	0.516	12.838
Cabarrus Co	0.173	2.867	5.213
Caldwell Co	0.444	0.139	30.539
Carteret Co	0.008	0.083	0.000
Catawba Co	4.192	112.800	22.153
Chatham Co	7.014	20.487	3.800
Chowan Co	0.028	0.137	0.010
Cleveland Co	0.687	3.790	2.486
Columbus Co	12.211	6.987	3.885
Craven Co	3.585	4.175	4.196
Cumberland Co	0.412	2.956	7.072
Dare Co	0.008	0.271	0.004
Davidson Co	2.466	12.859	23.927
Davie Co	0.078	0.039	3.841
Duplin Co	0.888	1.978	0.017
Durham Co	0.301	1.046	5.706
Edgecombe Co	0.347	5.818	0.020
Forsyth Co	1.917	8.835	20.874
Franklin Co	0.009	0.101	0.122
Gaston Co	3.083	70.313	8.958
Graham Co	0.017	0.020	1.450
Granville Co	0.294	0.105	2.661
Guilford Co	0.158	1.829	40.535
Halifax Co	12.957	11.343	1.002
Harnett Co	0.204	0.563	0.464
Haywood Co	6.879	11.915	4.067

County	CO	NOx	VOC
Henderson Co	0.023	0.400	5.133
Hertford Co	0.017	0.148	0.828
Hoke Co	0.004	0.019	3.829
Iredell Co	2.927	8.949	5.109
Jackson Co	0.004	0.045	0.000
Johnston Co	0.018	0.145	2.218
Lee Co	0.971	0.235	1.403
Lenoir Co	0.110	2.429	0.592
Lincoln Co	0.118	2.551	2.368
Mc Dowell Co	0.645	0.609	2.221
Martin Co	23.577	9.479	6.539
Mecklenburg Co	2.616	2.914	22.978
Mitchell Co	0.113	0.015	2.193
Montgomery Co	0.047	0.008	0.017
Moore Co	0.015	0.003	1.826
Nash Co	0.442	0.928	0.491
New Hanover Co	36.352	76.530	5.676
Northampton Co	0.123	0.273	0.195
Onslow Co	0.073	0.955	0.016
Orange Co	3.223	0.748	0.009
Pasquotank Co	0.011	0.018	1.122
Pender Co	0.012	0.022	0.007
Person Co	5.063	188.510	1.706
Pitt Co	0.322	0.624	1.549
Randolph Co	0.021	0.058	2.528
Richmond Co	0.025	0.101	0.002
Robeson Co	0.612	18.817	1.994
Rockingham Co	5.954	33.903	7.896
Rowan Co	1.290	30.602	10.634
Rutherford Co	1.890	41.944	3.548
Scotland Co	0.501	7.276	5.356
Stanly Co	14.149	1.178	2.002
Stokes Co	7.872	341.620	0.945
Surry Co	5.356	0.942	5.817
Transylvania Co	0.183	5.212	2.858
Union Co	0.030	0.152	2.483
Vance Co	0.035	1.242	0.000
Wake Co	0.237	0.810	10.774
Washington Co	0.001	0.004	0.000
Watauga Co	0.015	0.051	0.001

County	CO	NOx	VOC
Wayne Co	6.873	37.740	3.048
Wilkes Co	3.232	0.731	7.472
Wilson Co	0.177	2.020	2.376
Yadkin Co	0.000	0.000	0.092
State total	**196.096**	**1172.466**	**357.102**

Stationary Area Sources Emissions

County	CO	NOx	VOC
Alamance Co	3.51	0.74	7.71
Alexander Co	1.47	0.15	2.95
Alleghany Co	0.50	0.09	0.89
Anson Co	2.62	0.53	2.24
Ashe Co	1.25	0.14	1.50
Avery Co	0.81	0.11	1.02
Beaufort Co	17.77	0.61	12.42
Bertie Co	2.12	0.14	2.90
Bladen Co	4.26	0.42	4.46
Brunswick Co	5.08	0.64	4.57
Buncombe Co	4.71	1.31	14.23
Burke Co	3.15	0.55	6.27
Cabarrus Co	3.80	1.07	6.84
Caldwell Co	2.53	0.31	4.78
Camden Co	4.87	0.08	2.55
Carteret Co	10.09	0.61	6.93
Caswell Co	2.46	0.23	1.65
Catawba Co	4.60	0.90	12.14
Chatham Co	2.46	0.50	3.65
Cherokee Co	1.14	0.13	2.15
Chowan Co	1.63	0.10	1.42
Clay Co	0.40	0.08	0.56
Cleveland Co	5.14	0.84	7.25
Columbus Co	6.50	0.41	7.36
Craven Co	5.04	0.77	6.98
Cumberland Co	15.31	3.34	22.74
Currituck Co	4.30	0.13	2.46
Dare Co	1.65	0.13	2.13
Davidson Co	6.02	1.35	10.66
Davie Co	2.52	0.26	2.57
Duplin Co	8.32	0.45	6.68
Durham Co	2.61	1.88	16.40

County	CO	NOx	VOC
Edgecombe Co	5.67	1.22	5.88
Forsyth Co	5.33	1.54	14.36
Franklin Co	5.19	0.29	3.63
Gaston Co	4.10	1.76	12.04
Gates Co	1.18	0.09	1.34
Graham Co	0.45	0.08	0.45
Granville Co	3.50	0.38	3.15
Greene Co	6.06	0.17	3.11
Guilford Co	10.27	4.13	26.45
Halifax Co	3.57	0.91	4.17
Harnett Co	6.80	0.78	6.02
Haywood Co	2.06	0.32	4.36
Henderson Co	3.44	0.75	5.20
Hertford Co	1.17	0.12	1.90
Hoke Co	3.32	0.20	2.29
Hyde Co	6.38	0.07	3.63
Iredell Co	5.28	0.99	8.84
Jackson Co	1.49	0.23	2.00
Johnston Co	9.60	1.08	10.43
Jones Co	1.44	0.11	1.48
Lee Co	2.19	0.75	4.24
Lenoir Co	7.82	0.41	6.24
Lincoln Co	3.17	0.48	4.09
Mc Dowell Co	1.81	0.72	3.06
Macon Co	1.31	0.14	1.95
Madison Co	1.05	0.30	1.46
Martin Co	3.28	0.38	2.69
Mecklenburg Co	13.05	11.58	32.00
Mitchell Co	0.81	0.40	1.00
Montgomery Co	1.55	0.14	1.91
Moore Co	3.76	0.57	5.33
Nash Co	5.64	0.97	7.73
New Hanover Co	2.25	1.00	7.77
Northampton Co	2.75	0.39	1.91
Onslow Co	4.81	0.34	8.71
Orange Co	3.91	0.87	6.69
Pamlico Co	8.65	1.87	4.18
Pasquotank Co	9.77	0.13	5.21
Pender Co	4.66	0.21	3.74
Perquimans Co	4.64	0.10	3.12

County	CO	NOx	VOC
Person Co	4.45	0.41	2.74
Pitt Co	13.70	0.82	10.06
Polk Co	0.99	0.20	1.09
Randolph Co	5.89	0.78	9.82
Richmond Co	3.11	1.75	3.17
Robeson Co	19.68	1.45	16.70
Rockingham Co	6.30	1.03	5.91
Rowan Co	6.17	1.16	7.78
Rutherford Co	2.60	0.68	4.32
Sampson Co	10.48	0.36	7.84
Scotland Co	3.44	0.46	3.01
Stanly Co	5.11	0.29	4.81
Stokes Co	2.26	0.27	2.65
Surry Co	3.87	0.25	6.09
Swain Co	0.65	0.10	0.86
Transylvania Co	1.15	0.21	1.70
Tyrrell Co	7.03	0.07	3.50
Union Co	12.04	0.83	10.72
Vance Co	2.70	0.52	3.21
Wake Co	14.01	6.55	30.98
Warren Co	2.03	0.21	1.97
Washington Co	9.82	0.30	4.33
Watauga Co	1.38	0.15	2.71
Wayne Co	15.36	2.66	12.00
Wilkes Co	3.08	0.25	4.23
Wilson Co	7.26	1.30	6.96
Yadkin Co	2.82	0.16	3.54
Yancey Co	0.83	0.14	1.19
State Total	**479.96**	**79.33**	**596.72**

Nonroad Sources Emissions

County	CO	NOx	VOC
Alamance Co	29.18	0.20	2.59
Alexander Co	4.11	0.05	0.40
Alleghany Co	2.58	0.05	0.21
Anson Co	4.38	0.38	0.52
Ashe Co	3.94	0.05	0.42
Avery Co	5.29	0.05	0.59
Beaufort Co	13.65	0.39	2.76
Bertie Co	6.31	0.05	1.15

County	CO	NOx	VOC
Bladen Co	8.67	0.27	1.32
Brunswick Co	26.98	0.36	4.76
Buncombe Co	47.91	0.49	4.76
Burke Co	14.94	0.22	1.54
Cabarrus Co	41.70	0.34	3.69
Caldwell Co	16.69	0.06	1.78
Camden Co	2.96	0.05	1.01
Carteret Co	46.97	0.28	14.15
Caswell Co	2.26	0.13	0.22
Catawba Co	46.58	0.41	4.49
Chatham Co	12.56	0.32	1.51
Cherokee Co	4.23	0.05	0.57
Chowan Co	3.97	0.05	1.13
Clay Co	2.18	0.05	0.39
Cleveland Co	21.14	0.37	1.92
Columbus Co	9.81	0.20	1.14
Craven Co	23.26	0.46	2.93
Cumberland Co	64.64	2.73	11.73
Currituck Co	14.97	0.06	4.58
Dare Co	45.32	0.05	17.81
Davidson Co	30.28	0.69	2.88
Davie Co	7.20	0.14	0.84
Duplin Co	9.94	0.27	1.04
Durham Co	67.33	0.49	6.52
Edgecombe Co	10.95	0.73	1.03
Forsyth Co	89.05	0.47	7.62
Franklin Co	7.82	0.14	0.81
Gaston Co	49.26	0.64	4.29
Gates Co	1.56	0.05	0.23
Graham Co	1.40	0.05	0.25
Granville Co	12.71	0.19	1.31
Greene Co	2.43	0.09	0.25
Guilford Co	182.94	1.51	16.10
Halifax Co	8.66	0.55	0.95
Harnett Co	21.12	0.34	1.88
Haywood Co	11.23	0.16	1.18
Henderson Co	29.86	0.25	3.64
Hertford Co	4.12	0.05	0.49
Hoke Co	3.44	0.08	0.31
Hyde Co	24.88	0.05	11.57

County	CO	NOx	VOC
Iredell Co	23.40	0.30	2.31
Jackson Co	6.85	0.12	0.78
Johnston Co	32.64	0.69	3.13
Jones Co	1.82	0.07	0.17
Lee Co	16.36	0.43	1.51
Lenoir Co	15.85	0.23	1.48
Lincoln Co	13.58	0.24	1.36
Mc Dowell Co	7.94	0.54	1.03
Macon Co	10.84	0.05	1.03
Madison Co	1.72	0.21	0.18
Martin Co	4.61	0.27	0.50
Mecklenburg Co	325.43	3.57	29.32
Mitchell Co	3.54	0.31	0.45
Montgomery Co	4.99	0.05	0.60
Moore Co	27.58	0.27	2.28
Nash Co	21.08	0.54	1.94
New Hanover Co	56.63	0.81	6.90
Northampton Co	4.28	0.27	0.69
Onslow Co	25.81	0.12	4.08
Orange Co	29.41	0.23	3.25
Pamlico Co	13.06	1.81	5.40
Pasquotank Co	9.74	0.06	1.51
Pender Co	12.46	0.05	1.85
Perquimans Co	3.91	0.06	1.28
Person Co	8.34	0.20	0.88
Pitt Co	23.99	0.46	2.19
Polk Co	2.89	0.11	0.25
Randolph Co	27.26	0.25	2.43
Richmond Co	14.22	1.40	1.60
Robeson Co	19.58	0.82	1.97
Rockingham Co	15.60	0.37	1.54
Rowan Co	27.64	0.70	2.72
Rutherford Co	12.77	0.38	1.25
Sampson Co	10.29	0.11	1.01
Scotland Co	8.53	0.25	0.91
Stanly Co	15.92	0.12	1.63
Stokes Co	7.77	0.12	0.77
Surry Co	28.72	0.05	2.63
Swain Co	4.71	0.05	1.13
Transylvania Co	14.82	0.10	2.40

County	CO	NOx	VOC
Tyrrell Co	6.53	0.05	2.92
Union Co	45.86	0.42	4.03
Vance Co	6.31	0.28	0.79
Wake Co	233.69	2.82	23.24
Warren Co	3.44	0.12	0.59
Washington Co	5.57	0.24	1.47
Watauga Co	9.95	0.05	1.16
Wayne Co	28.11	2.27	2.84
Wilkes Co	16.07	0.05	1.50
Wilson Co	22.44	0.75	2.14
Yadkin Co	6.52	0.05	0.58
Yancey Co	7.33	0.08	0.84
State Total	**2411.70**	**39.09**	**293.67**

Highway Mobile Sources Emissions

County	CO	NOx	VOC
Alamance Co	107.43	14.92	9.43
Alexander Co	21.16	2.17	1.83
Alleghany Co	8.95	0.90	0.78
Anson Co	26.77	3.05	2.46
Ashe Co	19.45	1.89	1.72
Avery Co	17.39	1.87	1.56
Beaufort Co	38.64	3.91	3.54
Bertie Co	24.72	2.65	2.22
Bladen Co	37.65	3.75	3.29
Brunswick Co	74.31	8.08	6.67
Buncombe Co	178.76	27.37	15.47
Burke Co	80.26	13.91	6.89
Cabarrus Co	63.42	11.80	5.86
Caldwell Co	53.96	5.51	5.05
Camden Co	9.34	1.00	0.84
Carteret Co	55.26	6.04	5.06
Caswell Co	18.33	1.95	1.65
Catawba Co	122.92	15.90	11.16
Chatham Co	43.63	4.87	4.01
Cherokee Co	19.38	2.22	1.78
Chowan Co	10.51	1.07	0.95
Clay Co	6.42	0.67	0.55
Cleveland Co	77.65	10.50	6.91
Columbus Co	50.24	5.25	4.60

County	CO	NOx	VOC
Craven Co	64.58	6.80	6.10
Cumberland Co	223.26	30.32	20.98
Currituck Co	21.99	2.38	1.85
Dare Co	49.33	5.11	4.33
Davidson Co	150.84	27.56	12.92
Davie Co	37.20	8.36	3.07
Duplin Co	51.46	8.29	4.53
Durham Co	142.33	24.90	12.74
Edgecombe Co	45.16	4.52	4.15
Forsyth Co	207.45	32.63	20.60
Franklin Co	34.03	3.57	3.01
Gaston Co	90.70	17.44	8.71
Gates Co	10.46	1.17	0.95
Graham Co	5.44	0.52	0.49
Granville Co	48.29	9.91	4.14
Greene Co	16.62	1.68	1.46
Guilford Co	274.51	44.36	27.54
Halifax Co	60.25	12.55	5.15
Harnett Co	70.89	10.13	6.33
Haywood Co	67.59	14.74	5.71
Henderson Co	64.43	10.18	5.67
Hertford Co	19.29	2.00	1.70
Hoke Co	20.66	2.23	1.85
Hyde Co	5.58	0.57	0.48
Iredell Co	135.50	30.72	11.44
Jackson Co	35.85	4.13	3.18
Johnston Co	131.26	27.54	11.23
Jones Co	16.28	1.83	1.50
Lee Co	44.31	4.53	4.19
Lenoir Co	52.16	5.06	4.96
Lincoln Co	40.85	4.19	3.69
Mc Dowell Co	47.19	10.22	4.03
Macon Co	26.13	2.85	2.35
Madison Co	15.11	1.64	1.35
Martin Co	26.79	2.83	2.48
Mecklenburg Co	392.69	73.30	38.40
Mitchell Co	11.18	1.14	1.02
Montgomery Co	29.30	3.61	2.59
Moore Co	61.28	6.19	5.59
Nash Co	104.62	17.95	9.32

County	CO	NOx	VOC
New Hanover Co	87.27	9.11	8.50
Northampton Co	28.88	5.33	2.48
Onslow Co	80.37	8.05	7.73
Orange Co	62.77	18.46	5.55
Pamlico Co	10.44	0.97	0.94
Pasquotank Co	20.29	2.00	1.98
Pender Co	47.14	8.32	4.10
Perquimans Co	10.17	1.13	0.94
Person Co	24.33	2.42	2.22
Pitt Co	91.52	8.97	8.59
Polk Co	21.35	4.74	1.83
Randolph Co	122.08	17.26	10.75
Richmond Co	39.91	4.17	3.80
Robeson Co	127.44	22.67	11.10
Rockingham Co	77.73	7.94	7.21
Rowan Co	102.00	17.76	9.08
Rutherford Co	49.44	5.02	4.50
Sampson Co	61.77	8.73	5.44
Scotland Co	34.46	3.59	3.21
Stanly Co	42.33	4.14	3.95
Stokes Co	28.49	2.87	2.57
Surry Co	78.33	12.38	6.98
Swain Co	16.94	1.88	1.50
Transylvania Co	23.80	2.44	2.13
Tyrrell Co	4.24	0.48	0.39
Union Co	54.05	7.20	5.23
Vance Co	38.11	6.67	3.34
Wake Co	306.80	57.16	27.42
Warren Co	17.90	3.68	1.54
Washington Co	13.77	1.55	1.27
Watauga Co	33.04	3.63	3.10
Wayne Co	81.79	7.98	7.66
Wilkes Co	56.78	5.89	5.12
Wilson Co	71.21	10.72	6.54
Yadkin Co	39.27	7.03	3.44
Yancey Co	13.30	1.48	1.22
State Total	**6138.89**	**924.70**	**559.38**

8 APPENDIX B

Mecklenburg County

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*Convert MOBILE5 Registration Fractions to MOBILE6-Based Registration Fractions
*
*Calendar Year:      1996.000User-Input
*
*MOBILE5b Reg Fractions
*     0.114  0.097  0.086  0.083  0.077  0.084  0.069  0.062  0.051  0.044
*     0.040  0.039  0.033  0.027  0.022  0.016  0.012  0.007  0.004  0.003
*     0.003  0.004  0.003  0.002  0.018
*     0.090  0.080  0.076  0.075  0.062  0.066  0.066  0.048  0.040  0.037
*     0.034  0.042  0.040  0.035  0.033  0.024  0.021  0.013  0.009  0.008
*     0.008  0.012  0.012  0.009  0.060
*     0.123  0.148  0.096  0.088  0.065  0.071  0.054  0.039  0.023  0.021
*     0.030  0.034  0.031  0.021  0.021  0.020  0.013  0.008  0.007  0.006
*     0.007  0.012  0.010  0.010  0.042
*     0.123  0.104  0.061  0.093  0.060  0.077  0.058  0.046  0.025  0.023
*     0.023  0.030  0.047  0.027  0.025  0.023  0.018  0.008  0.008  0.009
*     0.009  0.014  0.011  0.009  0.069
*     0.114  0.097  0.086  0.083  0.077  0.084  0.069  0.062  0.051  0.044
*     0.040  0.039  0.033  0.027  0.022  0.016  0.012  0.007  0.004  0.003
*     0.003  0.004  0.003  0.002  0.018
*     0.090  0.080  0.076  0.075  0.062  0.066  0.066  0.048  0.040  0.037
*     0.034  0.042  0.040  0.035  0.033  0.024  0.021  0.013  0.009  0.008
*     0.008  0.012  0.012  0.009  0.060
*     0.155  0.141  0.081  0.100  0.066  0.083  0.056  0.041  0.030  0.032
*     0.055  0.048  0.027  0.028  0.016  0.014  0.008  0.004  0.003  0.002
*     0.002  0.003  0.002  0.001  0.002
*     0.141  0.111  0.088  0.081  0.074  0.061  0.049  0.035  0.027  0.017
*     0.015  0.301  0.000  0.000  0.000  0.000  0.000  0.000  0.000  0.000
*     0.000  0.000  0.000  0.000  0.000
*
*
* MOBILE6 Vehicle Classes:
*  1  LDV    Light-Duty Vehicles (Passenger Cars)
*  2  LDT1   Light-Duty Trucks 1 (0-6,000 lbs. GVWR, 0-3750 lbs. LVW)
*  3  LDT2   Light Duty Trucks 2 (0-6,000 lbs. GVWR, 3751-5750 lbs. LVW)
*  4  LDT3   Light Duty Trucks 3 (6,001-8500 lbs. GVWR, 0-3750 lbs. LVW)
*  5  LDT4   Light Duty Trucks 4 (6,001-8500 lbs. GVWR, 3751-5750 lbs. LVW)
*  6  HDV2B  Class 2b Heavy Duty Vehicles (8501-10,000 lbs. GVWR)
*  7  HDV3   Class 3 Heavy Duty Vehicles (10,001-14,000 lbs. GVWR)
*  8  HDV4   Class 4 Heavy Duty Vehicles (14,001-16,000 lbs. GVWR)
*  9  HDV5   Class 5 Heavy Duty Vehicles (16,001-19,500 lbs. GVWR)
* 10  HDV6   Class 6 Heavy Duty Vehicles (19,501-26,000 lbs. GVWR)
* 11  HDV7   Class 7 Heavy Duty Vehicles (26,001-33,000 lbs. GVWR)
* 12  HDV8A  Class 8a Heavy Duty Vehicles (33,001-60,000 lbs. GVWR)
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* 13  HDV8B  Class 8b Heavy Duty Vehicles (>60,000 lbs. GVWR)
* 14  HDBS   School Busses
* 15  HDBT   Transit and Urban Busses
* 16  MC     Motorcycles (All)
*
REG DIST
*                 RESULTING MOBILE6-BASED REGISTRATION FRACTIONS
*
*MOBILE6 REGISTRATION FRACTIONS BY VEHICLE CLASS AND AGE
* LDV          M5 LDGV
     1  0.114  0.097  0.086  0.083  0.077  0.084  0.069  0.062  0.051  0.044
        0.040  0.039  0.033  0.027  0.022  0.016  0.012  0.007  0.004  0.003
        0.003  0.004  0.003  0.002  0.018
* LDT1         M5 LDGT1
     2  0.090  0.080  0.076  0.075  0.062  0.066  0.066  0.048  0.040  0.037
        0.034  0.042  0.040  0.035  0.033  0.024  0.021  0.013  0.009  0.008
        0.008  0.012  0.012  0.009  0.060
* LDT2         M5 LDGT1
     3  0.090  0.080  0.076  0.075  0.062  0.066  0.066  0.048  0.040  0.037
        0.034  0.042  0.040  0.035  0.033  0.024  0.021  0.013  0.009  0.008
        0.008  0.012  0.012  0.009  0.060
* LDT3         M5 LDGT2
     4  0.123  0.148  0.096  0.088  0.065  0.071  0.054  0.039  0.023  0.021
        0.030  0.034  0.031  0.021  0.021  0.020  0.013  0.008  0.007  0.006
        0.007  0.012  0.010  0.010  0.042
* LDT4         M5 LDGT2
     5  0.123  0.148  0.096  0.088  0.065  0.071  0.054  0.039  0.023  0.021
        0.030  0.034  0.031  0.021  0.021  0.020  0.013  0.008  0.007  0.006
        0.007  0.012  0.010  0.010  0.042
* HDV2B         M5 HDVs (Combined HDGV and HDDV)
     6  0.137  0.120  0.070  0.096  0.063  0.080  0.057  0.044  0.027  0.027
        0.037  0.038  0.039  0.027  0.021  0.019  0.013  0.007  0.006  0.006
        0.006  0.009  0.007  0.006  0.040
* HDV3         M5 HDVs (Combined HDGV and HDDV)
     7  0.137  0.120  0.070  0.096  0.063  0.080  0.057  0.044  0.027  0.027
        0.037  0.038  0.039  0.027  0.021  0.019  0.013  0.007  0.006  0.006
        0.006  0.009  0.007  0.006  0.040
* HDV4         M5 HDVs (Combined HDGV and HDDV)
     8  0.137  0.120  0.070  0.096  0.063  0.080  0.057  0.044  0.027  0.027
        0.037  0.038  0.039  0.027  0.021  0.019  0.013  0.007  0.006  0.006
        0.006  0.009  0.007  0.006  0.040
* HDV5         M5 HDVs (Combined HDGV and HDDV)
     9  0.137  0.120  0.070  0.096  0.063  0.080  0.057  0.044  0.027  0.027
        0.037  0.038  0.039  0.027  0.021  0.019  0.013  0.007  0.006  0.006
        0.006  0.009  0.007  0.006  0.040
* HDV6         M5 HDVs (Combined HDGV and HDDV)
    10  0.137  0.120  0.070  0.096  0.063  0.080  0.057  0.044  0.027  0.027
        0.037  0.038  0.039  0.027  0.021  0.019  0.013  0.007  0.006  0.006
        0.006  0.009  0.007  0.006  0.040
* HDV7         M5 HDVs (Combined HDGV and HDDV)
    11  0.137  0.120  0.070  0.096  0.063  0.080  0.057  0.044  0.027  0.027
```

0.037 0.038 0.039 0.027 0.021 0.019 0.013 0.007 0.006 0.006
0.006 0.009 0.007 0.006 0.040
* HDV8a M5 HDVs (Combined HDGV and HDDV)
12 0.137 0.120 0.070 0.096 0.063 0.080 0.057 0.044 0.027 0.027
0.037 0.038 0.039 0.027 0.021 0.019 0.013 0.007 0.006 0.006
0.006 0.009 0.007 0.006 0.040
* HDV8b M5 HDVs (Combined HDGV and HDDV)
13 0.137 0.120 0.070 0.096 0.063 0.080 0.057 0.044 0.027 0.027
0.037 0.038 0.039 0.027 0.021 0.019 0.013 0.007 0.006 0.006
0.006 0.009 0.007 0.006 0.040
* HDBS M5 HDVs (Combined HDGV and HDDV)
14 0.137 0.120 0.070 0.096 0.063 0.080 0.057 0.044 0.027 0.027
0.037 0.038 0.039 0.027 0.021 0.019 0.013 0.007 0.006 0.006
0.006 0.009 0.007 0.006 0.040
* HDBT M5 HDDVs
15 0.155 0.141 0.081 0.100 0.066 0.083 0.056 0.041 0.030 0.032
0.055 0.048 0.027 0.028 0.016 0.014 0.008 0.004 0.003 0.002
0.002 0.003 0.002 0.001 0.002
* Motorcycles M5 MC
16 0.141 0.111 0.088 0.081 0.074 0.061 0.049 0.035 0.027 0.017
0.015 0.301 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000

<u>Triad</u>

*Convert MOBILE5 Registration Fractions to MOBILE6-Based Registration Fractions
*
*Calendar Year: 1996.000User-Input
*
*MOBILE5b Reg Fractions
* 0.101 0.080 0.075 0.073 0.070 0.081 0.066 0.063 0.054 0.048
* 0.045 0.046 0.040 0.034 0.028 0.021 0.016 0.009 0.005 0.004
* 0.004 0.005 0.004 0.004 0.024
* 0.077 0.066 0.065 0.066 0.054 0.062 0.067 0.047 0.043 0.037
* 0.034 0.045 0.044 0.039 0.039 0.027 0.025 0.016 0.012 0.010
* 0.010 0.014 0.014 0.012 0.075
* 0.081 0.089 0.078 0.078 0.065 0.080 0.064 0.050 0.033 0.032
* 0.037 0.041 0.038 0.030 0.031 0.029 0.018 0.011 0.009 0.009
* 0.006 0.014 0.013 0.012 0.052
* 0.078 0.079 0.049 0.062 0.058 0.080 0.051 0.041 0.033 0.027
* 0.034 0.043 0.040 0.031 0.038 0.029 0.018 0.013 0.011 0.016
* 0.014 0.020 0.016 0.015 0.104
* 0.101 0.080 0.075 0.073 0.070 0.081 0.066 0.063 0.054 0.048
* 0.045 0.046 0.040 0.034 0.028 0.021 0.016 0.009 0.005 0.004
* 0.004 0.005 0.004 0.004 0.024
* 0.077 0.066 0.065 0.066 0.054 0.062 0.067 0.047 0.043 0.037
* 0.034 0.045 0.044 0.039 0.039 0.027 0.025 0.016 0.012 0.010
* 0.010 0.014 0.014 0.012 0.075
* 0.170 0.141 0.087 0.100 0.074 0.079 0.067 0.042 0.032 0.027
* 0.033 0.032 0.029 0.024 0.018 0.014 0.010 0.004 0.004 0.003

```
*        0.002   0.002   0.002   0.001   0.003
*        0.134   0.102   0.072   0.070   0.071   0.051   0.049   0.041   0.027   0.021
*        0.018   0.344   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
*        0.000   0.000   0.000   0.000   0.000
*
*
* MOBILE6 Vehicle Classes:
*  1  LDV    Light-Duty Vehicles (Passenger Cars)
*  2  LDT1   Light-Duty Trucks 1 (0-6,000 lbs. GVWR, 0-3750 lbs. LVW)
*  3  LDT2   Light Duty Trucks 2 (0-6,000 lbs. GVWR, 3751-5750 lbs. LVW)
*  4  LDT3   Light Duty Trucks 3 (6,001-8500 lbs. GVWR, 0-3750 lbs. LVW)
*  5  LDT4   Light Duty Trucks 4 (6,001-8500 lbs. GVWR, 3751-5750 lbs. LVW)
*  6  HDV2B  Class 2b Heavy Duty Vehicles (8501-10,000 lbs. GVWR)
*  7  HDV3   Class 3 Heavy Duty Vehicles (10,001-14,000 lbs. GVWR)
*  8  HDV4   Class 4 Heavy Duty Vehicles (14,001-16,000 lbs. GVWR)
*  9  HDV5   Class 5 Heavy Duty Vehicles (16,001-19,500 lbs. GVWR)
* 10  HDV6   Class 6 Heavy Duty Vehicles (19,501-26,000 lbs. GVWR)
* 11  HDV7   Class 7 Heavy Duty Vehicles (26,001-33,000 lbs. GVWR)
* 12  HDV8A  Class 8a Heavy Duty Vehicles (33,001-60,000 lbs. GVWR)
* 13  HDV8B  Class 8b Heavy Duty Vehicles (>60,000 lbs. GVWR)
* 14  HDBS   School Busses
* 15  HDBT   Transit and Urban Busses
* 16  MC     Motorcycles (All)
*
REG DIST
*                RESULTING MOBILE6-BASED REGISTRATION FRACTIONS
*
*MOBILE6 REGISTRATION FRACTIONS BY VEHICLE CLASS AND AGE
* LDV          M5 LDGV
      1  0.101   0.080   0.075   0.073   0.070   0.081   0.066   0.063   0.054   0.048
         0.045   0.046   0.040   0.034   0.028   0.021   0.016   0.009   0.005   0.004
         0.004   0.005   0.004   0.004   0.024
* LDT1         M5 LDGT1
      2  0.077   0.066   0.065   0.066   0.054   0.062   0.067   0.047   0.043   0.037
         0.034   0.045   0.044   0.039   0.039   0.027   0.025   0.016   0.012   0.010
         0.010   0.014   0.014   0.012   0.075
* LDT2         M5 LDGT1
      3  0.077   0.066   0.065   0.066   0.054   0.062   0.067   0.047   0.043   0.037
         0.034   0.045   0.044   0.039   0.039   0.027   0.025   0.016   0.012   0.010
         0.010   0.014   0.014   0.012   0.075
* LDT3         M5 LDGT2
      4  0.081   0.089   0.078   0.078   0.065   0.080   0.064   0.050   0.033   0.032
         0.037   0.041   0.038   0.030   0.031   0.029   0.018   0.011   0.009   0.009
         0.006   0.014   0.013   0.012   0.052
* LDT4         M5 LDGT2
      5  0.081   0.089   0.078   0.078   0.065   0.080   0.064   0.050   0.033   0.032
         0.037   0.041   0.038   0.030   0.031   0.029   0.018   0.011   0.009   0.009
         0.006   0.014   0.013   0.012   0.052
* HDV2B          M5 HDVs (Combined HDGV and HDDV)
      6  0.118   0.106   0.065   0.079   0.065   0.079   0.058   0.042   0.032   0.027
         0.033   0.038   0.035   0.028   0.029   0.022   0.015   0.009   0.008   0.010
```

0.009 0.012 0.010 0.009 0.060
* HDV3 M5 HDVs (Combined HDGV and HDDV)
7 0.118 0.106 0.065 0.079 0.065 0.079 0.058 0.042 0.032 0.027
0.033 0.038 0.035 0.028 0.029 0.022 0.015 0.009 0.008 0.010
0.009 0.012 0.010 0.009 0.060
* HDV4 M5 HDVs (Combined HDGV and HDDV)
8 0.118 0.106 0.065 0.079 0.065 0.079 0.058 0.042 0.032 0.027
0.033 0.038 0.035 0.028 0.029 0.022 0.015 0.009 0.008 0.010
0.009 0.012 0.010 0.009 0.060
* HDV5 M5 HDVs (Combined HDGV and HDDV)
9 0.118 0.106 0.065 0.079 0.065 0.079 0.058 0.042 0.032 0.027
0.033 0.038 0.035 0.028 0.029 0.022 0.015 0.009 0.008 0.010
0.009 0.012 0.010 0.009 0.060
* HDV6 M5 HDVs (Combined HDGV and HDDV)
10 0.118 0.106 0.065 0.079 0.065 0.079 0.058 0.042 0.032 0.027
0.033 0.038 0.035 0.028 0.029 0.022 0.015 0.009 0.008 0.010
0.009 0.012 0.010 0.009 0.060
* HDV7 M5 HDVs (Combined HDGV and HDDV)
11 0.118 0.106 0.065 0.079 0.065 0.079 0.058 0.042 0.032 0.027
0.033 0.038 0.035 0.028 0.029 0.022 0.015 0.009 0.008 0.010
0.009 0.012 0.010 0.009 0.060
* HDV8a M5 HDVs (Combined HDGV and HDDV)
12 0.118 0.106 0.065 0.079 0.065 0.079 0.058 0.042 0.032 0.027
0.033 0.038 0.035 0.028 0.029 0.022 0.015 0.009 0.008 0.010
0.009 0.012 0.010 0.009 0.060
* HDV8b M5 HDVs (Combined HDGV and HDDV)
13 0.118 0.106 0.065 0.079 0.065 0.079 0.058 0.042 0.032 0.027
0.033 0.038 0.035 0.028 0.029 0.022 0.015 0.009 0.008 0.010
0.009 0.012 0.010 0.009 0.060
* HDBS M5 HDVs (Combined HDGV and HDDV)
14 0.118 0.106 0.065 0.079 0.065 0.079 0.058 0.042 0.032 0.027
0.033 0.038 0.035 0.028 0.029 0.022 0.015 0.009 0.008 0.010
0.009 0.012 0.010 0.009 0.060
* HDBT M5 HDDVs
15 0.170 0.141 0.087 0.100 0.074 0.079 0.067 0.042 0.032 0.027
0.033 0.032 0.029 0.024 0.018 0.014 0.010 0.004 0.004 0.003
0.002 0.002 0.002 0.001 0.003
* Motorcycles M5 MC
16 0.134 0.102 0.072 0.070 0.071 0.051 0.049 0.041 0.027 0.021
0.018 0.344 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000

Wake County

*Convert MOBILE5 Registration Fractions to MOBILE6-Based Registration Fractions
*
*Calendar Year: 1996.000User-Input
*
*MOBILE5b Reg Fractions
* 0.114 0.091 0.085 0.080 0.075 0.083 0.069 0.063 0.052 0.047
* 0.042 0.040 0.034 0.029 0.023 0.017 0.012 0.007 0.004 0.003
* 0.003 0.003 0.003 0.002 0.019

```
*        0.090  0.081  0.080  0.083  0.060  0.066  0.069  0.049  0.037  0.037
*        0.034  0.041  0.039  0.034  0.037  0.025  0.021  0.013  0.009  0.008
*        0.006  0.011  0.010  0.009  0.051
*        0.101  0.117  0.083  0.095  0.057  0.121  0.069  0.048  0.034  0.034
*        0.025  0.037  0.032  0.019  0.018  0.017  0.010  0.007  0.004  0.005
*        0.006  0.010  0.008  0.007  0.036
*        0.109  0.076  0.057  0.088  0.069  0.088  0.049  0.041  0.041  0.030
*        0.036  0.039  0.035  0.027  0.028  0.026  0.016  0.009  0.007  0.009
*        0.010  0.014  0.012  0.010  0.074
*        0.114  0.091  0.085  0.080  0.075  0.083  0.069  0.063  0.052  0.047
*        0.042  0.040  0.034  0.029  0.023  0.017  0.012  0.007  0.004  0.003
*        0.003  0.003  0.003  0.002  0.019
*        0.090  0.081  0.080  0.083  0.060  0.066  0.069  0.049  0.037  0.037
*        0.034  0.041  0.039  0.034  0.037  0.025  0.021  0.013  0.009  0.008
*        0.006  0.011  0.010  0.009  0.051
*        0.163  0.137  0.087  0.103  0.067  0.074  0.044  0.035  0.032  0.054
*        0.040  0.044  0.029  0.026  0.018  0.016  0.010  0.004  0.004  0.003
*        0.002  0.002  0.001  0.001  0.004
*        0.138  0.105  0.080  0.070  0.068  0.053  0.053  0.041  0.029  0.021
*        0.022  0.320  0.000  0.000  0.000  0.000  0.000  0.000  0.000  0.000
*        0.000  0.000  0.000  0.000  0.000
*
*
* MOBILE6 Vehicle Classes:
*  1  LDV    Light-Duty Vehicles (Passenger Cars)
*  2  LDT1   Light-Duty Trucks 1 (0-6,000 lbs. GVWR, 0-3750 lbs. LVW)
*  3  LDT2   Light Duty Trucks 2 (0-6,000 lbs. GVWR, 3751-5750 lbs. LVW)
*  4  LDT3   Light Duty Trucks 3 (6,001-8500 lbs. GVWR, 0-3750 lbs. LVW)
*  5  LDT4   Light Duty Trucks 4 (6,001-8500 lbs. GVWR, 3751-5750 lbs. LVW)
*  6  HDV2B  Class 2b Heavy Duty Vehicles (8501-10,000 lbs. GVWR)
*  7  HDV3   Class 3 Heavy Duty Vehicles (10,001-14,000 lbs. GVWR)
*  8  HDV4   Class 4 Heavy Duty Vehicles (14,001-16,000 lbs. GVWR)
*  9  HDV5   Class 5 Heavy Duty Vehicles (16,001-19,500 lbs. GVWR)
* 10  HDV6   Class 6 Heavy Duty Vehicles (19,501-26,000 lbs. GVWR)
* 11  HDV7   Class 7 Heavy Duty Vehicles (26,001-33,000 lbs. GVWR)
* 12  HDV8A  Class 8a Heavy Duty Vehicles (33,001-60,000 lbs. GVWR)
* 13  HDV8B  Class 8b Heavy Duty Vehicles (>60,000 lbs. GVWR)
* 14  HDBS   School Busses
* 15  HDBT   Transit and Urban Busses
* 16  MC     Motorcycles (All)
*
REG DIST
*                RESULTING MOBILE6-BASED REGISTRATION FRACTIONS
*
*MOBILE6 REGISTRATION FRACTIONS BY VEHICLE CLASS AND AGE
* LDV          M5 LDGV
     1  0.114  0.091  0.085  0.080  0.075  0.083  0.069  0.063  0.052  0.047
        0.042  0.040  0.034  0.029  0.023  0.017  0.012  0.007  0.004  0.003
        0.003  0.003  0.003  0.002  0.019
* LDT1         M5 LDGT1
     2  0.090  0.081  0.080  0.083  0.060  0.066  0.069  0.049  0.037  0.037
```

0.034 0.041 0.039 0.034 0.037 0.025 0.021 0.013 0.009 0.008
0.006 0.011 0.010 0.009 0.051
* LDT2 M5 LDGT1
3 0.090 0.081 0.080 0.083 0.060 0.066 0.069 0.049 0.037 0.037
0.034 0.041 0.039 0.034 0.037 0.025 0.021 0.013 0.009 0.008
0.006 0.011 0.010 0.009 0.051
* LDT3 M5 LDGT2
4 0.101 0.117 0.083 0.095 0.057 0.121 0.069 0.048 0.034 0.034
0.025 0.037 0.032 0.019 0.018 0.017 0.010 0.007 0.004 0.005
0.006 0.010 0.008 0.007 0.036
* LDT4 M5 LDGT2
5 0.101 0.117 0.083 0.095 0.057 0.121 0.069 0.048 0.034 0.034
0.025 0.037 0.032 0.019 0.018 0.017 0.010 0.007 0.004 0.005
0.006 0.010 0.008 0.007 0.036
* HDV2B M5 HDVs (Combined HDGV and HDDV)
6 0.133 0.102 0.070 0.095 0.068 0.082 0.047 0.039 0.037 0.040
0.038 0.041 0.032 0.027 0.023 0.022 0.014 0.007 0.006 0.006
0.007 0.009 0.007 0.006 0.043
* HDV3 M5 HDVs (Combined HDGV and HDDV)
7 0.133 0.102 0.070 0.095 0.068 0.082 0.047 0.039 0.037 0.040
0.038 0.041 0.032 0.027 0.023 0.022 0.014 0.007 0.006 0.006
0.007 0.009 0.007 0.006 0.043
* HDV4 M5 HDVs (Combined HDGV and HDDV)
8 0.133 0.102 0.070 0.095 0.068 0.082 0.047 0.039 0.037 0.040
0.038 0.041 0.032 0.027 0.023 0.022 0.014 0.007 0.006 0.006
0.007 0.009 0.007 0.006 0.043
* HDV5 M5 HDVs (Combined HDGV and HDDV)
9 0.133 0.102 0.070 0.095 0.068 0.082 0.047 0.039 0.037 0.040
0.038 0.041 0.032 0.027 0.023 0.022 0.014 0.007 0.006 0.006
0.007 0.009 0.007 0.006 0.043
* HDV6 M5 HDVs (Combined HDGV and HDDV)
10 0.133 0.102 0.070 0.095 0.068 0.082 0.047 0.039 0.037 0.040
0.038 0.041 0.032 0.027 0.023 0.022 0.014 0.007 0.006 0.006
0.007 0.009 0.007 0.006 0.043
* HDV7 M5 HDVs (Combined HDGV and HDDV)
11 0.133 0.102 0.070 0.095 0.068 0.082 0.047 0.039 0.037 0.040
0.038 0.041 0.032 0.027 0.023 0.022 0.014 0.007 0.006 0.006
0.007 0.009 0.007 0.006 0.043
* HDV8a M5 HDVs (Combined HDGV and HDDV)
12 0.133 0.102 0.070 0.095 0.068 0.082 0.047 0.039 0.037 0.040
0.038 0.041 0.032 0.027 0.023 0.022 0.014 0.007 0.006 0.006
0.007 0.009 0.007 0.006 0.043
* HDV8b M5 HDVs (Combined HDGV and HDDV)
13 0.133 0.102 0.070 0.095 0.068 0.082 0.047 0.039 0.037 0.040
0.038 0.041 0.032 0.027 0.023 0.022 0.014 0.007 0.006 0.006
0.007 0.009 0.007 0.006 0.043
* HDBS M5 HDVs (Combined HDGV and HDDV)
14 0.133 0.102 0.070 0.095 0.068 0.082 0.047 0.039 0.037 0.040
0.038 0.041 0.032 0.027 0.023 0.022 0.014 0.007 0.006 0.006
0.007 0.009 0.007 0.006 0.043
* HDBT M5 HDDVs

15 0.163 0.137 0.087 0.103 0.067 0.074 0.044 0.035 0.032 0.054
0.040 0.044 0.029 0.026 0.018 0.016 0.010 0.004 0.004 0.003
0.002 0.002 0.001 0.001 0.004
* Motorcycles M5 MC
16 0.138 0.105 0.080 0.070 0.068 0.053 0.053 0.041 0.029 0.021
0.022 0.320 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000

North Carolina

REG DIST
*Convert MOBILE5 Registration Fractions to MOBILE6-Based Registration Fractions
*
*Calendar Year: 1995.000User-Input
*
*MOBILE5b Reg Fractions
* 0.064 0.057 0.066 0.063 0.067 0.065 0.074 0.064 0.061 0.052
* 0.048 0.046 0.049 0.044 0.037 0.031 0.025 0.019 0.011 0.006
* 0.005 0.005 0.007 0.006 0.028
* 0.060 0.052 0.056 0.055 0.060 0.049 0.054 0.059 0.045 0.038
* 0.036 0.035 0.045 0.046 0.042 0.043 0.033 0.031 0.021 0.014
* 0.013 0.011 0.018 0.017 0.067
* 0.245 0.038 0.057 0.040 0.046 0.028 0.059 0.034 0.023 0.016
* 0.017 0.012 0.018 0.016 0.009 0.009 0.008 0.005 0.004 0.002
* 0.002 0.003 0.005 0.004 0.300
* 0.118 0.032 0.027 0.020 0.031 0.024 0.031 0.017 0.015 0.015
* 0.011 0.013 0.014 0.012 0.010 0.010 0.009 0.006 0.003 0.003
* 0.003 0.004 0.005 0.004 0.563
* 0.064 0.057 0.066 0.063 0.067 0.065 0.074 0.064 0.061 0.052
* 0.048 0.046 0.049 0.044 0.037 0.031 0.025 0.019 0.011 0.006
* 0.005 0.005 0.007 0.006 0.028
* 0.060 0.052 0.056 0.055 0.060 0.049 0.054 0.059 0.045 0.038
* 0.036 0.035 0.045 0.046 0.042 0.043 0.033 0.031 0.021 0.014
* 0.013 0.011 0.018 0.017 0.067
* 0.115 0.095 0.110 0.060 0.083 0.057 0.067 0.052 0.040 0.029
* 0.029 0.041 0.041 0.040 0.034 0.024 0.023 0.018 0.007 0.007
* 0.006 0.005 0.006 0.003 0.008
* 0.223 0.028 0.024 0.018 0.016 0.016 0.012 0.012 0.009 0.007
* 0.005 0.630 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
* 0.000 0.000 0.000 0.000 0.000
*
*
* MOBILE6 Vehicle Classes:
* 1 LDV Light-Duty Vehicles (Passenger Cars)
* 2 LDT1 Light-Duty Trucks 1 (0-6,000 lbs. GVWR, 0-3750 lbs. LVW)
* 3 LDT2 Light Duty Trucks 2 (0-6,000 lbs. GVWR, 3751-5750 lbs. LVW)
* 4 LDT3 Light Duty Trucks 3 (6,001-8500 lbs. GVWR, 0-3750 lbs. LVW)
* 5 LDT4 Light Duty Trucks 4 (6,001-8500 lbs. GVWR, 3751-5750 lbs. LVW)
* 6 HDV2B Class 2b Heavy Duty Vehicles (8501-10,000 lbs. GVWR)
* 7 HDV3 Class 3 Heavy Duty Vehicles (10,001-14,000 lbs. GVWR)

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*  8  HDV4   Class 4 Heavy Duty Vehicles (14,001-16,000 lbs. GVWR)
*  9  HDV5   Class 5 Heavy Duty Vehicles (16,001-19,500 lbs. GVWR)
* 10  HDV6   Class 6 Heavy Duty Vehicles (19,501-26,000 lbs. GVWR)
* 11  HDV7   Class 7 Heavy Duty Vehicles (26,001-33,000 lbs. GVWR)
* 12  HDV8A  Class 8a Heavy Duty Vehicles (33,001-60,000 lbs. GVWR)
* 13  HDV8B  Class 8b Heavy Duty Vehicles (>60,000 lbs. GVWR)
* 14  HDBS   School Busses
* 15  HDBT   Transit and Urban Busses
* 16  MC     Motorcycles (All)
*
*                 RESULTING MOBILE6-BASED REGISTRATION FRACTIONS
*
*MOBILE6 REGISTRATION FRACTIONS BY VEHICLE CLASS AND AGE
* LDV         M5 LDGV
    1  0.064  0.057  0.066  0.063  0.067  0.065  0.074  0.064  0.061  0.052
       0.048  0.046  0.049  0.044  0.037  0.031  0.025  0.019  0.011  0.006
       0.005  0.005  0.007  0.006  0.028
* LDT1        M5 LDGT1
    2  0.060  0.052  0.056  0.055  0.060  0.049  0.054  0.059  0.045  0.038
       0.036  0.035  0.045  0.046  0.042  0.043  0.033  0.031  0.021  0.014
       0.013  0.011  0.018  0.017  0.067
* LDT2        M5 LDGT1
    3  0.060  0.052  0.056  0.055  0.060  0.049  0.054  0.059  0.045  0.038
       0.036  0.035  0.045  0.046  0.042  0.043  0.033  0.031  0.021  0.014
       0.013  0.011  0.018  0.017  0.067
* LDT3        M5 LDGT2
    4  0.245  0.038  0.057  0.040  0.046  0.028  0.059  0.034  0.023  0.016
       0.017  0.012  0.018  0.016  0.009  0.009  0.008  0.005  0.004  0.002
       0.002  0.003  0.005  0.004  0.300
* LDT4        M5 LDGT2
    5  0.245  0.038  0.057  0.040  0.046  0.028  0.059  0.034  0.023  0.016
       0.017  0.012  0.018  0.016  0.009  0.009  0.008  0.005  0.004  0.002
       0.002  0.003  0.005  0.004  0.300
* HDV2B        M5 HDVs (Combined HDGV and HDDV)
    6  0.117  0.059  0.062  0.037  0.053  0.038  0.046  0.032  0.025  0.021
       0.018  0.025  0.025  0.024  0.020  0.016  0.015  0.011  0.005  0.005
       0.004  0.004  0.005  0.004  0.327
* HDV3        M5 HDVs (Combined HDGV and HDDV)
    7  0.117  0.059  0.062  0.037  0.053  0.038  0.046  0.032  0.025  0.021
       0.018  0.025  0.025  0.024  0.020  0.016  0.015  0.011  0.005  0.005
       0.004  0.004  0.005  0.004  0.327
* HDV4        M5 HDVs (Combined HDGV and HDDV)
    8  0.117  0.059  0.062  0.037  0.053  0.038  0.046  0.032  0.025  0.021
       0.018  0.025  0.025  0.024  0.020  0.016  0.015  0.011  0.005  0.005
       0.004  0.004  0.005  0.004  0.327
* HDV5        M5 HDVs (Combined HDGV and HDDV)
    9  0.117  0.059  0.062  0.037  0.053  0.038  0.046  0.032  0.025  0.021
       0.018  0.025  0.025  0.024  0.020  0.016  0.015  0.011  0.005  0.005
       0.004  0.004  0.005  0.004  0.327
* HDV6        M5 HDVs (Combined HDGV and HDDV)
   10  0.117  0.059  0.062  0.037  0.053  0.038  0.046  0.032  0.025  0.021
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     0.018   0.025   0.025   0.024   0.020   0.016   0.015   0.011   0.005   0.005
     0.004   0.004   0.005   0.004   0.327
* HDV7         M5 HDVs (Combined HDGV and HDDV)
   11   0.117   0.059   0.062   0.037   0.053   0.038   0.046   0.032   0.025   0.021
     0.018   0.025   0.025   0.024   0.020   0.016   0.015   0.011   0.005   0.005
     0.004   0.004   0.005   0.004   0.327
* HDV8a        M5 HDVs (Combined HDGV and HDDV)
   12   0.117   0.059   0.062   0.037   0.053   0.038   0.046   0.032   0.025   0.021
     0.018   0.025   0.025   0.024   0.020   0.016   0.015   0.011   0.005   0.005
     0.004   0.004   0.005   0.004   0.327
* HDV8b        M5 HDVs (Combined HDGV and HDDV)
   13   0.117   0.059   0.062   0.037   0.053   0.038   0.046   0.032   0.025   0.021
     0.018   0.025   0.025   0.024   0.020   0.016   0.015   0.011   0.005   0.005
     0.004   0.004   0.005   0.004   0.327
* HDBS         M5 HDVs (Combined HDGV and HDDV)
   14   0.117   0.059   0.062   0.037   0.053   0.038   0.046   0.032   0.025   0.021
     0.018   0.025   0.025   0.024   0.020   0.016   0.015   0.011   0.005   0.005
     0.004   0.004   0.005   0.004   0.327
* HDBT         M5 HDDVs
   15   0.115   0.095   0.110   0.060   0.083   0.057   0.067   0.052   0.040   0.029
     0.029   0.041   0.041   0.040   0.034   0.024   0.023   0.018   0.007   0.007
     0.006   0.005   0.006   0.003   0.008
* Motorcycles   M5 MC
   16   0.223   0.028   0.024   0.018   0.016   0.016   0.012   0.012   0.009   0.007
     0.005   0.630   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.000   0.000   0.000   0.000
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Prepared by the
Fayetteville Area Metropolitan Planning Organization Staff
in cooperation with
the
Cumberland County Air Quality Stakeholders
Mr. George Breece, Chair
and
Cumberland County Air Quality Technical Committee
Ms. Nancy Roy, AICP, Chair
and the
North Carolina Department of the Environment and Natural Resources
Division of Air Quality

Maurizia Chapman, AICP, Principal Planner
mchapman@co.cumberland.nc.us
Timothy J. Strickland, Planning Assistant
tstrickland@co.cumberland.nc.us